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HENRY S. GRAVES, Forester

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UTILIZATION OF ASH.

By W. D. Sterrett, *Forest Examiner.*

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INTRODUCTION.

Ash is one of the leading commercial hardwoods of the United States. Its importance is due to the intrinsic qualities of its wood; for the quantity cut annually and the available supply of standing timber are small in comparison with the output and supply of a number of other American hardwoods. United States census figures for the last 15 years indicate that, in the production of lumber, ash ranks eleventh among hardwoods, the annual cut amounting to from 2½ to 3 per cent of the hardwood lumber output and to less than 1 per cent of the total cut of all species. The peculiar merits of the wood, however, make it very valuable for a number of articles, such as handles, butter tubs, vehicles, and refrigerators. Thus it offers a wide range of possibilities for profitable utilization, and for that reason is an extremely desirable tree to encourage in woodlots.

The value of ash for different uses and the amount of the different species of ash used in various industries are given in this bulletin, and methods are indicated by which owners may utilize their ash timber profitably. This bulletin also contains an account of the properties of ash wood. The paragraphs on its mechanical properties are taken from a report by J. A. Newlin, engineer in the Forest Products Laboratory at Madison, Wis. Mr. Newlin's report is based on timber tests conducted by the laboratory on specimens mostly collected by the author. That part of the bulletin which deals with utilization by industries is based, for the most part, on studies of secondary wood-using industries in the different States carried on by

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the Office of Industrial Investigations of the Forest Service, from 1910 to 1913, inclusive.[1]

COMMERCIAL SPECIES.

There are 18 species of ash native to the United States, but 98 per cent of the ash lumber produced is from three species—white ash (*Fraxinus americana*), black ash (*F. nigra*), and green ash (*F. lanceolata*). The species which make up the remaining 2 per cent of the lumber output of ash are Oregon ash (*F. oregona*), blue ash (*F. quadrangulata*), Biltmore ash (*F. biltmoreana*), pumpkin ash (*F. profunda*), and red ash (*F. pennsylvanica*), all of which species have good cultural possibilities and are considered more important silviculturally than commercially. (Fig. 1.)

In the lumber trade ash lumber is often not distinguished as to kinds, all species being sold under the common name of ash. Much is sold under the name white ash to distinguish it from brown ash (also known as black ash, *F. nigra*), which has mechanical properties quite different from those of white ash but the same general appearance and structure and a more handsome grain. Lumber cut from all species, however, is often sold as white ash. The terms green, red, and Biltmore ash are not used at all in the lumber trade. Old-growth ash from continuously wet river bottom land is often called pumpkin ash because it is soft and brittle. The term is applied chiefly to pumpkin ash (*F. profunda*) and green ash (*F. lanceolata*). The terms black and blue ash are often used locally to designate standing ash timber, but do not necessarily refer to the species botanically known as *F. nigra* and *F. quadrangulata*. The term Oregon ash is seldom used in trade on the Pacific coast.

An estimate of the cut of ash by species in the different States is given in Table 1. The table is based on 1910 census data. From these data the cut of ash by counties was determined (see fig. 2), and careful estimates were made by the author of the proportion of each species in each county for which a report was made by the census. The table indicates roughly the commercial range of the important species.

[1] Compiled under the direction of J. C. Nellis, forest examiner.

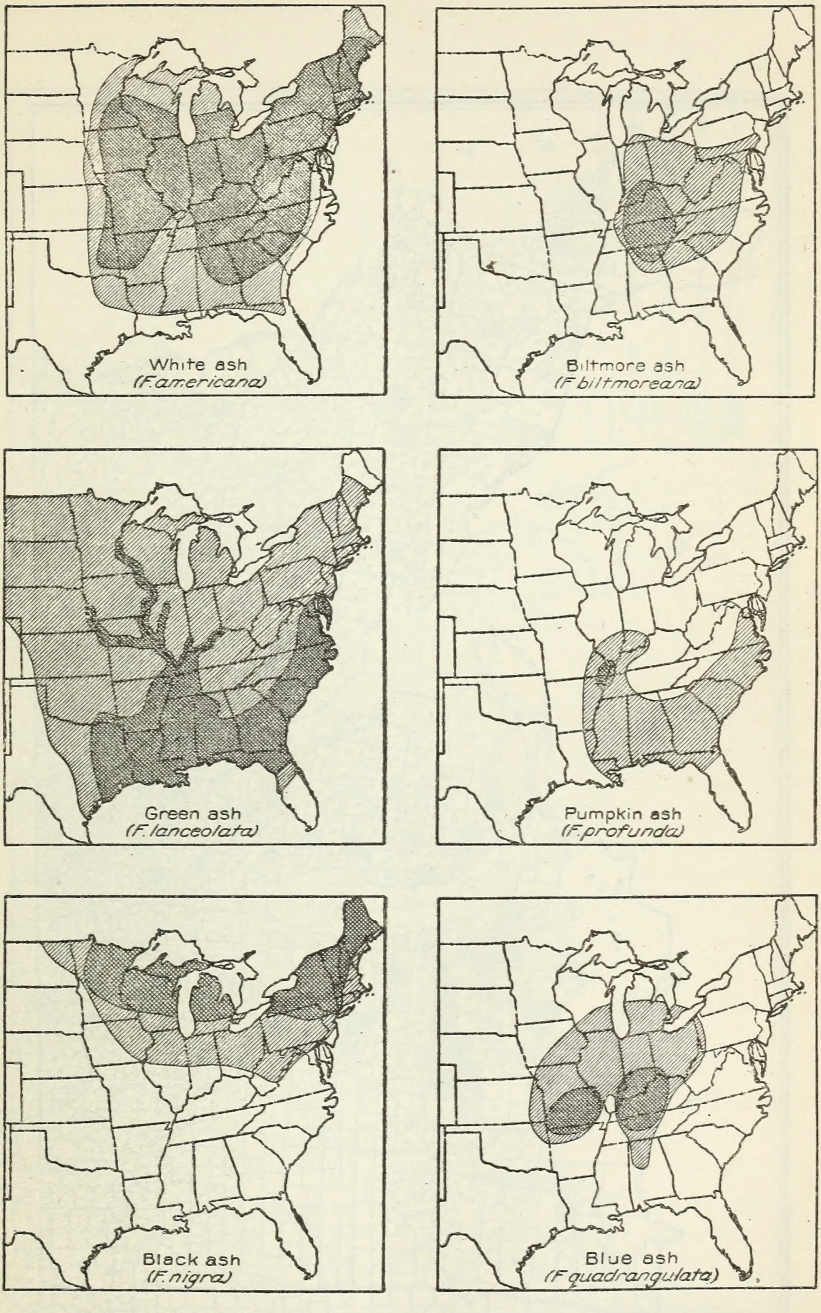


FIG. 1.—Commercial ashes. Data prepared by W. H. Lamb, of the Forest Service, and the author.

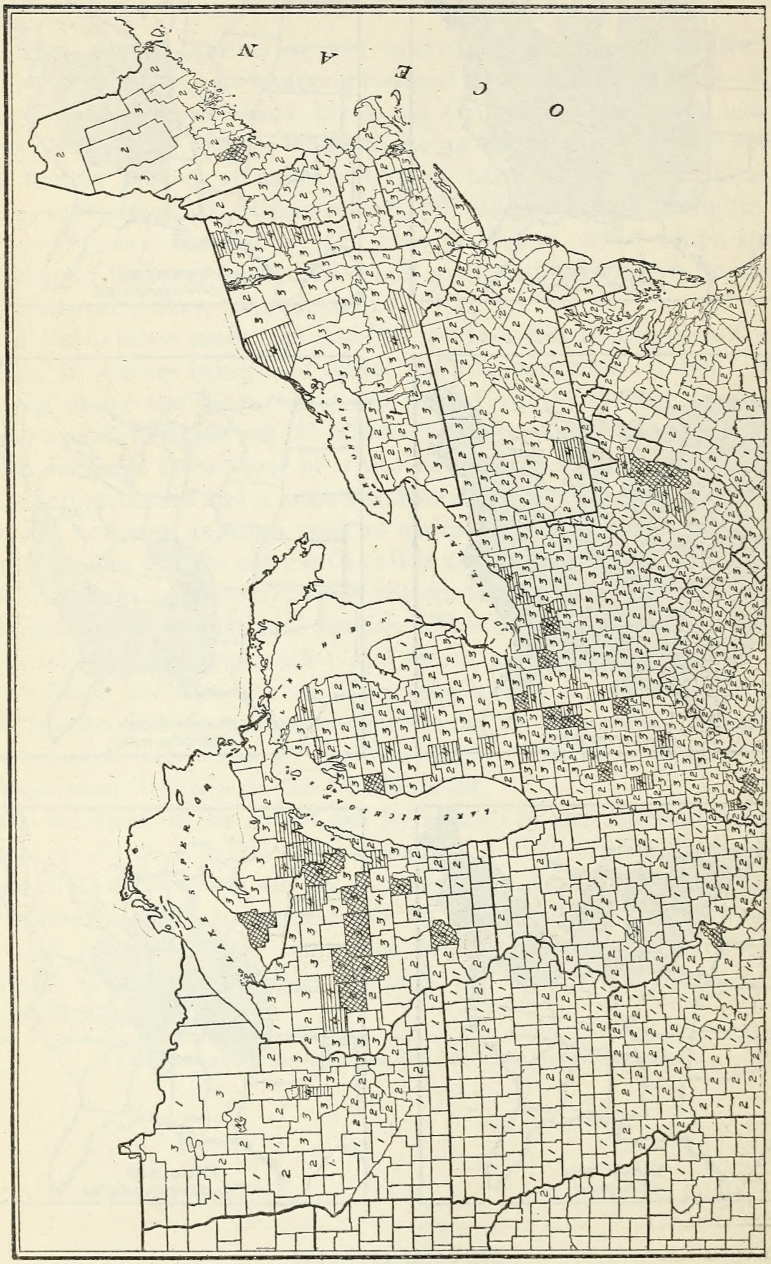
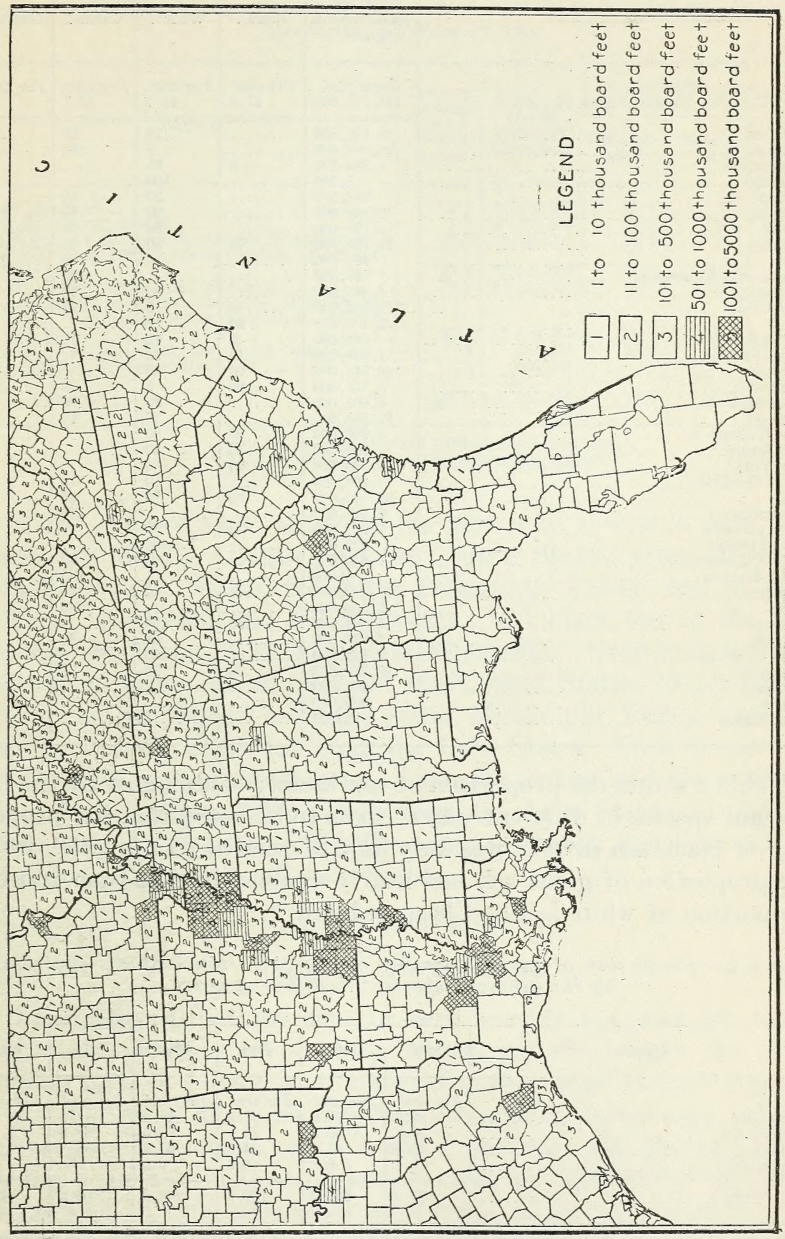


FIG. 2.—Lumber cut of


LEGEND
1 to 10 thousand board feet
11 to 100 thousand board feet
101 to 500 thousand board feet
501 to 1000 thousand board feet
1001 to 5000 thousand board feet

ash by counties, 1910.

TABLE 1.—*Estimated proportion contributed by the different species of ash to the total lumber cut of ash in 1910.*

	Total cut, 1910 (census figures).	Black.	White.	Green.	Oregon.
Total for United States	*Board feet.* 234,715,000	*Per cent.* 17.9	*Per cent.* 44.7	*Per cent.* 37.1	*Per cent.* 03.
Alabama	2,146,000	.....	20	80	.....
Arkansas	26,308,000	.....	5	95	.....
Connecticut	1,893,000	5	95	.....	.....
Delaware	1,000	.....	100	.....	.....
Florida	238,000	.....	20	80	.....
Georgia	2,859,000	.....	20	80	.....
Illinois	3,178,000	.....	30	70	.....
Indiana	19,765,000	10	80	10	.....
Iowa	463,000	.....	40	60	.....
Kansas and Nebraska	67,000	.....	.....	100	.....
Kentucky	8,943,000	.....	60	40	.....
Louisiana	13,302,000	.....	5	95	.....
Maine	3,104,000	20	80	.....	.....
Maryland	548,000	5	85	10	.....
Massachusetts	1,656,000	10	90	.....	.....
Michigan	19,513,000	60	40	.....	.....
Minnesota	3,151,000	80	5	15	.....
Mississippi	8,901,000	.....	20	80	.....
Missouri	12,560,000	.....	25	75	.....
New Hampshire	1,695,000	20	80	.....	.....
New Jersey	208,000	10	90	.....	.....
New York	9,386,000	20	80	.....	.....
North Carolina	3,426,000	.....	70	30	.....
Ohio	22,815,000	20	70	10	.....
Oklahoma	2,977,000	.....	.....	100	.....
Pennsylvania	7,227,000	20	80	.....	.....
Rhode Island	223,000	.....	100	.....	.....
South Carolina	1,650,000	.....	10	90	.....
South Dakota	4,000	.....	.....	100	.....
Tennessee	15,043,000	.....	60	40	.....
Texas	3,630,000	.....	.....	100	.....
Vermont	4,394,000	20	80	.....	.....
Virginia	2,988,000	.....	60	40	.....
West Virginia	7,183,000	.....	95	5	.....
Wisconsin	22,670,000	70	25	5	.....
California	206,000	.....	.....	.....	100
Oregon	299,000	.....	.....	.....	100
Washington	95,000	.....	.....	.....	100

Table 2 shows the proportion of ash lumber contributed by the important species in different years. It is to be noted that the proportion of black ash in 1914 was only half of what it was in 1899, while the proportion of green ash had nearly doubled in that time and the proportion of white ash had been reduced.

TABLE 2.—*Proportion of the ash lumber cut in the United States contributed by the different species*[1] *in different years.*

Species.	1899	1909	1910	1912	1914	1915
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Black ash	28.3	17.6	17.9	15.0	13.9	10.4
Green ash[1]	25.3	36.6	37.1	38.6	43.9	43.6
White ash[1]	45.0	45.6	44.7	45.9	41.7	45.9
Oregon ash	1.4	0.2	0.3	0.5	0.5	0.1
Total	100.0	100.0	100.0	100.0	100.0	100.0

[1] Under white ash is included a small proportion of Biltmore and blue ash, and under green ash a small proportion of pumpkin and red ash. This table is based on census data using the proportion of species given in Table 1.

Table 3 shows the proportion of the ash lumber cut derived from the important species in different regions of the United States in 1910.

TABLE 3.—*Proportion of the ash lumber cut of 1910 derived from the important species in different regions.*

Region.	Per cent of total cut in United States.	Total cut in the region in board feet.	Per cent of total in region.		
			White ash.[1]	Green ash.[2]	Black ash.
New England	5.5	12,965,000	83.8	.....	16.2
Middle Atlantic States	7.4	17,370,000	80.3	0.3	19.4
Lake States (Michigan, Wisconsin, Minnesota)	19.3	45,334,000	30.1	3.5	66.4
Ohio, Indiana, Illinois, West Virginia, Kentucky, Tennessee	32.8	76,927,000	70.1	21.4	8.5
South Atlantic States and Alabama	5.7	13,307,000	40.6	59.4	.....
Lower Mississippi Valley, including Missouri, Arkansas, Oklahoma, Texas, Louisiana, and Mississippi	28.8	67,678,000	10.2	89.8	.....
Kansas, Nebraska, Iowa, and South Dakota	.2	534,000	34.6	65.4	.....
Washington, Oregon, California [3]	.3	600,000	.....	.....	.....
Total	100.0	234,715,000	44.7	37.1	17.9

[1] Includes small per cent of Biltmore and blue ash.
[2] Includes small per cent of pumpkin and red ash.
[3] All Oregon ash.

Table 3 shows white ash to be the important species in New England, the Middle Atlantic, and the Central States; green ash in the South Atlantic States, the lower Mississippi Valley, and in Iowa, Kansas, Nebraska, and South Dakota; and black ash in the Lake States—Michigan, Wisconsin, and Minnesota. Over half the total supply of white ash comes from the Central States, 70 per cent of the green ash comes from the lower Mississippi Valley, and 71.5 per cent of the black ash from the Lake States. Over 60 per cent of the total supply of ash comes from the central and lower Mississippi Valley States, 19 per cent from the Lake States, 13 per cent from New England and Middle Atlantic States, and only 5.7 per cent from the South Atlantic States.

DEMAND AND SUPPLY.

QUANTITY USED ANNUALLY.

Practically all of the ash cut each year is required for use in so called secondary wood-using industries, which take the sawed lumber and, to a less extent, material in the rough form of logs and bolts, and use it in the manufacture of handles, butter tubs, vehicles, planing-mill products, etc. Table 4 indicates the present annual demand for ash in these industries and its distribution by States. According to this table a larger amount of ash was used in these industries than the census reported as being manufactured into lumber and cooperage stock. (See p. 8.) The excess is probably due to the manufacture of handles, butter tubs, and vehicle stock directly from logs and bolts.

TABLE 4.—*Ash used by secondary industries in the United States.*

State.	Quantity used annually.	State.	Quantity used annually.
	Feet b. m.		*Feet b. m.*
Illinois	51,311,000	Oklahoma	1,818,500
Michigan	33,220,619	West Virginia	1,763,300
Ohio	29,029,703	Louisiana	1,756,450
Arkansas	24,183,000	New Jersey	1,551,254
Iowa	19,827,442	South Carolina	1,518,000
Indiana	17,727,237	North Carolina	1,417,000
New York	17,556,225	Maryland	922,675
Wisconsin	14,339,000	California	816,798
Pennsylvania	14,304,627	Oregon	466,800
Missouri	10,528,675	Delaware	387,543
Tennessee	7,769,000	Kansas	287,629
Minnesota	6,280,592	Florida	280,163
Kentucky	4,498,500	Rhode Island	250,250
Maine	4,487,600	Nebraska	172,493
Virginia	4,182,403	Washington	130,900
Massachusetts	3,601,500	Colorado	130,650
New Hampshire	3,540,552	District of Columbia	107,800
Vermont	3,137,087	Utah	25,000
Connecticut	2,995,198	Arizona	5,500
Texas	2,393,940	Idaho	500
Alabama	2,330,500		
Georgia	2,236,877	Total	295,461,482
Mississippi	2,171,000		

THE ANNUAL CUT.

The census returns for the past decade indicate an annual cut of from two hundred to three hundred million feet of ash lumber. In rank in lumber production ash stands twentieth or twenty-first among all species. In addition to the lumber cut, from twenty-five to thirty-five million board feet[1] of ash is reported[2] to be used annually in slack cooperage for staves, heading, and hoops. The total annual cut of lumber and cooperage stock appears to be about the same for ash as for hickory or cottonwood.[2]

TABLE 5.—*Output of ash lumber, by States, in 1899 and from 1904 to 1915, inclusive, in 1,000 board feet; and average value of the product, f. o. b. mills in the United States.*

	1899	1904	1905	1906	1907	1908
Total number of mills reporting	31,833	18,277	11,666	22,393	28,850	31,231
Total number of mills cutting ash	.....	.....	2,653	.....	5,454	6,012
Average value per 1,000 board feet. f. o. b. mill	$15.84	$18.77	.....	$24.35	$25.01	$25.51
	1,000 board feet.	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*
Total cut of ash	269,120	169,178	159,634	214,460	252,040	225,367
Alabama	5,782	2,641	1,071	2,377	3,366	1,277
Arkansas	15,624	14,586	13,034	20,571	23,801	21,086
California	.....	.....	.....	.....	.....	10
Connecticut	158	292	904	2,118	1,884	1,535
Delaware	.....	.....	50	3	7	105
Florida	462	167	85	370	370	113
Georgia	992	426	553	967	1,320	1,605
Illinois	1,075	899	873	1,781	1,869	1,804
Indiana	27,603	25,606	13,340	19,631	19,359	19,997
Iowa	347	115	.....	848	422	302
Kansas and Nebraska	26	.....	.....	.....	.....	.....
Kentucky	4,877	4,246	12,939	8,999	10,405	8,629

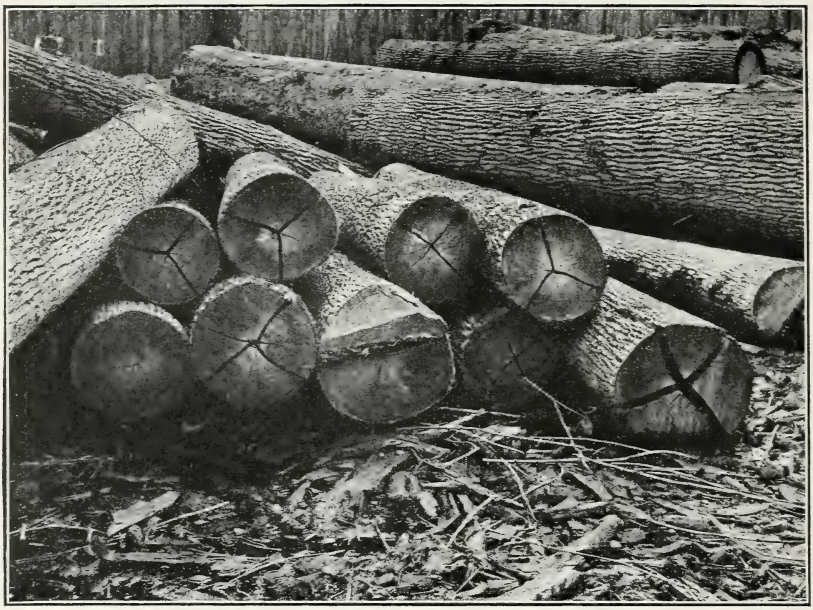
[1] Mostly from green ash in the lower Mississippi Valley.
[2] According to census reports.

F–31063

FIG. 1.—OLD GROWTH WHITE ASH IN THE SOUTHERN APPALACHIANS.
Very valuable for large dimension stock.

F–13920A

FIG. 2.—SIXTY-YEAR-OLD SECOND GROWTH WHITE ASH STAND IN CENTRAL OHIO.
Will cut 8,000 board feet per acre of excellent handle stock.



F-IWDS

FIG. 1.—GREEN ASH LOGS CUT FOR SEVERAL MONTHS. NORTHEASTERN ARKANSAS.
Note checking.

F-13345A

FIG. 2.—LARGE FELLED BLACK ASH TREE OF GOOD QUALITY AND GROWTH.
NORTHERN MICHIGAN.

TABLE 5.—*Output of ash lumber, by States, in 1899 and from 1904 to 1915, inclusive, in 1,000 board feet; and average value of the product, f. o. b. mills in the United States*—Continued.

	1899	1904	1905	1906	1907	1908
	1,000 board feet.	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*
Louisiana	4,979	2,987	1,493	3,382	7,586	7,976
Maine	1,259	105	1,279	1,667	4,912	3,136
Maryland	3	1	601	804	1,044	729
Massachusetts	120	2,281	614	2,017	2,032	2,214
Michigan	85,753	34,925	26,141	24,500	27,281	21,091
Minnesota	3,690	228	2,063	2,724	3,487	3,810
Mississippi	10,144	15,499	8,083	8,850	9,387	11,225
Missouri	10,458	5,356	4,308	7,972	10,067	9,068
New Hampshire	1,248	796	1,390	2,824	2,648	3,035
New Jersey	11	3	120	115	184	117
New York	8,956	2,796	9,900	15,585	16,175	15,293
North Carolina	3,617	3,833	4,111	4,769	4,834	3,829
Ohio	28,934	13,082	10,539	21,359	22,501	20,938
Oklahoma	100	1,840	.....	.....	893	3,802
Oregon	610	.....	1,530	1,516	778	789
Pennsylvania	4,677	2,448	6,691	9,484	12,568	7,716
Rhode Island	34	.....	159	240	545	223
South Carolina	1,371	4,213	7,460	1,636	2,934	5 190
Tennessee	18,100	8,950	5,819	12,404	19,099	15,490
Texas	6,793	2,826	1,988	2,824	2,960	1,459
Vermont	1,200	3,471	3,269	5,184	5,152	4,035
Virginia	1,060	291	656	2,362	3,267	1,411
Washington	3,203	150	205	11	289	390
West Virginia	2,207	2,729	2,938	4,895	9,003	7,534
Indian Territory	13,647	10,915	14,588	19,386	19,571	18,309
Wisconsin	.....	.....	440	285	.....	.....
All other States	.....	.....	.....	.....	40	95

	1909	1910	1911	1912	1913	1914	1915
Total number of mills reporting	48,112	31,934	28,107	29,648	21,668	27,750	16,815
Total number of mills cutting ash	8,930	6,944	6,348	6,491	3,348	3,649	3,486
Average value per 1,000 board feet f. o. b. mill	$24.44	$22.47	$21.21	$20.27	.....	.....	$22.15
	1,000 board feet.	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*
Total cut of ash	291,209	234,715	214,398	234,548	207,816	189,499	159,910
Alabama	3,387	2,146	2,267	1,974	1,394	1,917	1,736
Arkansas	33,212	26,308	20,138	23,681	31,019	18,172	18,957
California	.....	206	150	210	350	.....	.....
Connecticut	1,684	1,893	1,947	1,414	754	1,057	441
Delaware	61	1	2	25	50	5	2
Florida	282	238	208	290	2,042	964	2,163
Georgia	3,106	2,859	1,987	2,838	3,088	2,437	2,605
Illinois	2,894	3,178	2,244	2,774	1,860	6,017	2,520
Indiana	23,488	19,765	19,219	21,549	15,517	11,014	11,006
Iowa	788	463	557	442	138	100	234
Kansas and Nebraska	116	67	6	37	7	.....	.....
Kentucky	14,958	8,943	7,376	9,588	9,066	5,622	6,966
Louisiana	11,200	13,303	15,509	14,395	17,473	19,515	14,602
Maine	2,572	3,104	2,919	3,169	3,514	1,972	1,584
Maryland	2,166	548	743	555	92	178	225
Massachusetts	2,879	1,656	1,865	1,628	881	1,361	883
Michigan	24,865	19,513	14,127	14,280	8,681	8,893	7,839
Minnesota	3,326	3,151	2,978	3,235	1,480	2,009	2,254
Mississippi	15,017	8,901	6,443	9,051	9,914	8,086	7,381
Missouri	12,685	12,560	9,560	6,298	10,969	6,204	5,258
New Hampshire	2,554	1,695	1,637	1,759	903	1,155	1,090
New Jersey	183	208	236	175	60	274	318
New York	12,747	9,386	10,727	10,706	9,928	11,534	7,163
North Carolina	4,476	3,426	3,197	5,473	2,649	6,401	3,421
Ohio	25,753	22,815	21,995	26,100	12,967	10,717	8,618
Oklahoma	2,879	2,977	3,095	7,201	706	2,008	879
Oregon	455	299	149	884	146	809	100
Pennsylvania	9,814	7,227	9,368	10,336	5,742	6,980	5,625
Rhode Island	236	223	58	220	152	410	49
South Carolina	2,219	1,650	1,652	791	2,862	1,992	1,775
South Dakota	12	4	3	.....	.....	.....	.....
Tennessee	18,709	15,043	15,331	18,434	22,943	18,837	15,233
Texas	5,348	3,630	3,490	3,283	3,371	3,845	4,690
Vermont	4,531	4,394	4,244	3,971	2,990	4,428	3,188
Virginia	5,590	2,988	2,522	4,881	1,489	2,681	1,371
Washington	215	95	70	92	.....	75	80
West Virginia	9,171	7,183	8,371	8,110	9,761	6,520	5,911
Wisconsin	27,631	22,670	18,008	14,699	12,858	15,310	13,733

TABLE 6.—*Average value of ash lumber per 1,000 board feet f. o. b. mills, in different States, from 1906 to 1911, inclusive, and 1915.*

	1906	1907	1908	1909	1910	1911	1915
Alabama				$25.00	$19.46	$18.67	$24.79
Arkansas	$28.38	$25.31	$22.08	24.35	22.20	20.60	23.35
California					50.00		
Connecticut					25.85	21.36	19.15
Delaware							
Florida					30.75		16.02
Georgia				23.76	18.98	17.94	21.56
Illinois					22.62	23.83	19.51
Indiana	26.86	29.87	34.22	30.55	25.89	24.44	23.75
Iowa					27.42	24.75	30.66
Kansas and Nebraska							
Kentucky	23.51	22.93	22.81	21.85	21.65	20.89	23.69
Louisiana		27.43	23.11	21.75	20.77	21.36	22.47
Maine					19.73	17.44	18.54
Maryland					19.98	19.14	18.58
Massachusetts					21.45	20.47	18.79
Michigan	20.37	21.35	20.10	20.56	22.18	21.87	21.36
Minnesota				15.31	16.65	16.60	14.80
Mississippi	25.06	29.54	27.32	20.16	24.50	21.50	22.51
Missouri	29.20	32.08	39.00	23.34	25.32	20.84	21.75
New Hampshire					21.85	20.50	18.18
New Jersey					33.45	23.33	25.79
New York	24.00	18.00	31.00	23.00	22.76	21.46	23.90
North Carolina	26.48			17.96	15.85	17.50	20.11
Ohio	29.50	30.77	30.42	32.41	25.31	23.57	24.59
Oklahoma					23.85		20.87
Oregon					25.56	17.33	27.10
Pennsylvania	25.33	24.50	25.23	23.57	23.61	21.60	18.65
Rhode Island					26.33		25.97
South Carolina			20.95		23.07	17.50	20.19
South Dakota							
Tennessee	26.43	27.05	25.85	30.88	20.75	20.17	23.37
Texas				23.36	24.84	22.17	23.93
Vermont	20.46	19.96		19.94	19.12	20.25	18.33
Virginia				18.29	19.00	20.00	18.18
Washington					25.00		25.25
West Virginia		26.10	28.40	25.46	22.80	21.23	24.20
Wisconsin	18.80	19.83	19.44	18.21	19.73	18.73	19.96
All other States	21.73	23.93	20.88	22.23			

TABLE 7.—*Number of mills reporting lumber cut of ash in the different States.*

	1905	1907	1908	1909	1910	1911	1912	1913	1914	1915
Total	2,653	5,454	6,012	8,930	6,944	6,348	6,491	3,348	3,649	3,486
Alabama			42	97	65	64	62	18	33	29
Arkansas	88	196	151	258	166	150	157	92	111	87
California			1		4	1	1	1		
Connecticut			122	154	130	117	97	51	68	50
Delaware			2	3	1	1	1	1	1	1
Florida			4	10	5	5	6	8	6	6
Georgia			59	68	52	49	57	23	30	21
Illinois			164	213	154	133	152	41	53	37
Indiana	279	486	584	733	581	461	516	233	254	238
Iowa			44	126	80	76	74	14	6	38
Kansas and Nebraska			4	2	4	2	4	1		
Kentucky	157	399	450	583	483	376	412	161	131	156
Louisiana		41	36	49	43	54	50	47	65	49
Maine			165	184	142	123	132	92	92	82
Maryland			42	68	50	28	35	6	17	17
Massachusetts			152	157	104	115	112	32	58	64
Michigan	253	441	477	608	459	432	412	184	150	174
Minnesota			143	207	163	133	140	67	48	52
Mississippi	68	104	136	164	132	79	104	65	95	79
Missouri		150	232	354	282	235	238	87	55	68
New Hampshire			146	138	106	92	106	21	50	49
New Jersey			22	25	25	32	19	6	19	29
New York				963	743	897	690	927	809	702
North Carolina			152	192	164	145	163	65	68	77
Ohio	280	515	621	927	673	584	720	295	338	273
Oklahoma			56	80	59	52	64	17	47	18
Oregon			15	14	11	5	9	4	3	1
Pennsylvania	237	612	593	754	566	526	606	186	295	297

TABLE 7.—*Number of mills reporting lumber cut of ash in the different States*—Continued.

	1905	1907	1908	1909	1910	1911	1912	1913	1914	1915
Rhode Island	.....	.....	17	18	13	8	10	6	8	4
South Carolina	12	.....	12	20	20	18	20	13	15	15
South Dakota	.....	.....	.....	1	1	1	.....	.....	.....	.....
Tennessee	154	347	384	516	396	378	366	170	237	193
Texas	.....	.....	18	36	27	25	26	20	22	29
Vermont	.....	223	210	221	221	231	238	90	133	151
Virginia	.....	.....	100	181	158	154	122	38	58	51
Washington	.....	.....	6	4	3	2	2	.....	1	1
West Virginia	.....	209	207	288	250	226	224	82	86	135
Wisconsin	203	382	443	514	408	338	344	184	187	213
All other States	922	1,349	.....	.....	.....	.....	.....	.....	.....	.....

The output of ash lumber by States for the year 1899 and the years 1904 to 1914, inclusive, and the average price[1] received for the product f. o. b. mills in the United States, are shown in Table 5; and the average f. o. b. mill values in different States for 1906 to 1911, inclusive, in Table 6. The figures for 1899 and 1909 are the most complete, as they are based on decennial census returns; those for 1904, 1905, and 1906 are the least complete. The comparative completeness of the figures for each year is indicated to a certain extent by the total number of mills reporting, as given in Table 5, and the number of mills reporting lumber cuts of ash in the different States, as given in Table 7. There are a number of important points to be observed in these tables. First, that the annual production of ash was maintained or somewhat increased during the decade from 1900 to 1909, but since that time it has considerably decreased. Again, in average f. o. b. value per thousand board feet there was an increase of 54 per cent in 1909 over 1899. That this increase was not maintained during succeeding years is due largely to an increased proportion of lower grades in the total output. A general survey of the present supply of ash timber leads to the conclusion that the high-water mark in the production of ash lumber in the United States, both in regard to quantity and quality of output, has been passed, and it is not likely that either the amount or value of the 1909 cut will ever again be equaled.

Table 8 indicates the constant shifting in rank of the ash-producing States. In 1899 the cut in Michigan (which was from virgin forests) was greater than in any other three States, while in 1911 Michigan had dropped to seventh place in the production of ash lumber, with an output one-sixth as great as that of 1899. Ohio and Indiana, where the cut is now entirely from second growth, ranked third and fifth, respectively, in 1909, but rose to first and third places in 1911 and 1912, although in each case there was considerable decrease in the actual amount of the output.

[1] United States census reports.

TABLE 8.—*Rank of the different States in amount of ash lumber produced in the year 1899 and the years 1904 to 1915, inclusive.*

Rank.	1899	1904	1905	1906
1	Michigan	Michigan	Michigan	Michigan.
2	Ohio	Indiana	Wisconsin	Ohio.
3	Indiana	Mississippi	Indiana	Arkansas.
4	Tennessee	Arkansas	Arkansas	Indiana.
5	Arkansas	Ohio	Kentucky	Wisconsin.
6	Wisconsin	Wisconsin	Ohio	New York.
7	Missouri	Tennessee	New York	Tennessee.
8	Mississippi	Missouri	Mississippi	Pennsylvania.
9	New York	Kentucky	South Carolina	Kentucky.
10	Texas	South Carolina	Pennsylvania	Mississippi.
11	Alabama	North Carolina	Tennessee	Missouri.
12	Louisiana	Vermont	Missouri	Vermont.
13	Kentucky	Louisiana	North Carolina	West Virginia.
14	Pennsylvania	Texas	Vermont	North Carolina.
15	Minnesota	New York	West Virginia	Louisiana.
16	North Carolina	West Virginia	Minnesota	Texas.
17	Washington	Alabama	Texas	New Hampshire.
18	West Virginia	Pennsylvania	Oregon	Minnesota.
19	South Carolina	Massachusetts	Louisiana	Alabama.
20	Maine	Oklahoma	New Hampshire	Virginia.
21	New Hampshire	Illinois	Maine	Connecticut.
22	Vermont	New Hampshire	Alabama	Massachusetts.
23	Illinois	Georgia	Connecticut	Illinois.
24	Virginia	Connecticut	Illinois	Maine.
25	Georgia	Virginia	Virginia	South Carolina.
26	Oregon	Minnesota	Massachusetts	Oregon.
27	Florida	Florida	Maryland	Georgia.
28	Iowa	Washington	Georgia	Iowa.
29	Connecticut	Iowa	(Indian Territory)	Maryland.
30	Massachusetts	Maine	Washington	Florida.
31	Oklahoma	New Jersey	Rhode Island	(Indian Territory.)
32	Rhode Island	Maryland	New Jersey	Rhode Island.
33	Kansas and Nebraska.		Florida	New Jersey.
34	New Jersey		Delaware	Washington.
35	Maryland			Delaware.

Rank.	1907	1908	1909	1910
1	Michigan	Michigan	Arkansas	Arkansas.
2	Arkansas	Arkansas	Wisconsin	Ohio.
3	Ohio	Ohio	Ohio	Wisconsin.
4	Wisconsin	Indiana	Michigan	Indiana.
5	Indiana	Wisconsin	Indiana	Michigan.
6	Tennessee	Tennessee	Tennessee	Tennessee.
7	New York	New York	Mississippi	Louisiana.
8	Pennsylvania	Mississippi	Kentucky	Missouri.
9	Kentucky	Missouri	New York	New York.
10	Missouri	Kentucky	Missouri	Kentucky.
11	Mississippi	Louisiana	Louisiana	Mississippi.
12	West Virginia	Pennsylvania	Pennsylvania	Pennsylvania.
13	Louisiana	West Virginia	West Virginia	West Virginia.
14	Vermont	South Carolina	Virginia	Vermont.
15	Maine	Vermont	Texas	Texas.
16	North Carolina	North Carolina	Vermont	North Carolina.
17	Minnesota	Minnesota	North Carolina	Illinois.
18	Alabama	Oklahoma	Alabama	Minnesota.
19	Virginia	Maine	Minnesota	Maine.
20	Texas	New Hampshire	Georgia	Virginia.
21	South Carolina	Massachusetts	Illinois	Oklahoma.
22	New Hampshire	Illinois	Massachusetts	Georgia.
23	Massachusetts	Georgia	Maine	Alabama.
24	Connecticut	Connecticut	New Hampshire	Connecticut.
25	Illinois	Texas	South Carolina	New Hampshire.
26	Georgia	Virginia	Maryland	Massachusetts.
27	Maryland	Alabama	Connecticut	South Carolina.
28	Oklahoma	Oregon	Iowa	Maryland.
29	Oregon	Maryland	Oregon	Iowa.
30	Rhode Island	Washington	Florida	Oregon.
31	Iowa	Iowa	Rhode Island	Florida.
32	Florida	Rhode Island	Washington	Rhode Island.
33	Washington	New Jersey	New Jersey	New Jersey.
34	New Jersey	Florida	Kansas and Nebraska.	California.
35	Delaware	Delaware	Delaware	Washington.
36		California	South Dakota	Kansas and Nebraska.
37				South Dakota.
38				Delaware.

TABLE 8.—*Rank of the different States in amount of ash lumber produced in the year 1899 and the years 1904 to 1915, inclusive*—Continued.

Rank.	1911	1912	1913	1914	1915
1	Ohio	Ohio	Arkansas	Louisiana	Arkansas.
2	Arkansas	Arkansas	Tennessee	Tennessee	Tennessee.
3	Indiana	Indiana	Louisiana	Arkansas	Louisiana.
4	Wisconsin	Tennessee	Indiana	Wisconsin	Wisconsin
5	Tennessee	Wisconsin	Ohio	New York	Indiana.
6	Louisiana	Louisiana	Wisconsin	Indiana	Ohio.
7	Michigan	Michigan	Missouri	Ohio	Michigan.
8	New York	Pennsylvania	New York	Michigan	Mississippi.
9	Missouri	New York	Mississippi	Mississippi	New York.
10	Pennsylvania	Kentucky	West Virginia	Pennsylvania	Kentucky.
11	West Virginia	Mississippi	Kentucky	West Virginia	West Virginia.
12	Kentucky	West Virginia	Michigan	North Carolina	Pennsylvania.
13	Mississippi	Oklahoma	Pennsylvania	Missouri	Missouri.
14	Vermont	Missouri	Maine	Illinois	Texas.
15	Texas	North Carolina	Texas	Kentucky	North Carolina.
16	North Carolina	Virginia	Georgia	Vermont	Vermont.
17	Oklahoma	Vermont	Vermont	Texas	Georgia.
18	Minnesota	Texas	South Carolina	Virginia	Illinois.
19	Maine	Minnesota	North Carolina	Georgia	Minnesota.
20	Virginia	Maine	Florida	Minnesota	Florida.
21	Alabama	Georgia	Illinois	Oklahoma	South Carolina.
22	Illinois	Illinois	Virginia	South Carolina	Alabama.
23	Georgia	Alabama	Minnesota	Maine	Maine.
24	Connecticut	New Hampshire	Alabama	Alabama	Virginia.
25	Massachusetts	Massachusetts	New Hampshire	Massachusetts	New Hampshire.
26	South Carolina	Connecticut	Massachusetts	New Hampshire	Massachusetts.
27	New Hampshire	Oregon	Connecticut	Connecticut	Oklahoma.
28	Maryland	South Carolina	Oklahoma	Florida	Connecticut.
29	Iowa	Maryland	California	Oregon	New Jersey.
30	New Jersey	Iowa	Rhode Island	Rhode Island	Iowa.
31	Florida	Florida	Oregon	New Jersey	Maryland.
32	California	Rhode Island	Iowa	Maryland	Oregon.
33	Oregon	California	Maryland	Iowa	Washington.
34	Washington	New Jersey	New Jersey	Washington	Rhode Island.
35	Rhode Island	Washington	Delaware	Delaware	Delaware.
36	Kansas and Nebraska.	Kansas and Nebraska.	Kansas and Nebraska.	.....	.....
37	South Dakota	Delaware	.....	.....	.....
38	Delaware	.....	.....	.....	.....

These changes indicate the waning importance of old growth as compared with second growth. The decline in total production is a result of the inability of the second growth to keep pace with the annual cut. This condition will be increasingly marked as the supply of old growth disappears. Since 1912 the lower Mississippi Valley States, Arkansas, Louisiana, and Tennessee, which cut about half and half from old and young growth, have been in the lead.

Table 9 indicates the proportion of the ash lumber cut contributed by different regions in the United States for the years 1899, 1909, 1910, 1912, and 1914. It shows a great decrease in the amount of ash lumber cut in the Lake States, which was chiefly from virgin supplies of black ash, and a great increase in the supply from the lower Mississippi Valley States,[1] chiefly from green ash, both second and old growth, on intrinsically good agricultural land which will ultimately be cleared for farming. New England, the Middle States, and the Central States, where the supply is chiefly from second-growth white ash on more or less permanent woodlots, are holding their own or increasing in the proportion which they contribute to the ash lumber output.

[1] If the cut of ash for cooperage stock were added to the lumber cut, the lower Mississippi Valley States would be considerably further in the lead.

TABLE 9.—*Proportion of the ash lumber cut in the United States contributed by different regions in different years.*

Region.	1899	1909	1910	1912	1914	1915
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
(1) New England	1.5	5.0	5.5	5.2	5.5	4.5
(2) Middle Atlantic	5.1	8.6	7.4	9.3	10.0	8.3
(3) Lake States (Michigan, Wisconsin, and Minnesota)	38.3	19.2	19.3	13.7	13.8	14.9
(4) Ohio, Indiana, Illinois, West Virginia, Kentucky, and Tennessee	30.8	32.6	32.8	36.9	31.0	31.4
(5) South Atlantic and Alabama	4.9	6.5	5.7	6.9	8.6	8.2
(6) Lower Mississippi Valley, including Missouri, Arkansas, Oklahoma, Texas, Louisiana, and Mississippi	17.9	27.6	28.8	27.3	30.5	32.4
(7) Kansas, Nebraska, Iowa, and South Dakota	.1	.3	.2	.2	.1	.2
(8) Washington, Oregon, and California	1.4	.2	.3	.5	.5	.1
Total	100.0	100.0	100.0	100.0	100.0	100.0

THE SUPPLY OF ASH TIMBER.

About two-thirds of the present supply of ash is second growth, chiefly in small timber tracts and wood lots attached to farms, and about one-third is virgin timber, chiefly in large tracts. Usually it forms less than 5 per cent of the stand in which it grows. Black ash in the Lake States and green ash in the lower Mississippi Valley often form from 20 to 25 per cent of the original stand, but these original supplies are rapidly becoming exhausted and will seldom be reproduced. The green ash, however, is for the most part on agricultural land which ultimately will be drained and used for farming. At the present rate of cutting the supply of virgin ash will be practically exhausted in the next 10 years; but this does not mean that the annual cut will be very greatly diminished in the next decade, as it is already largely dependent on second growth. Furthermore, ash is a tree which, with a little encouragement, will maintain or increase the proportions it forms of second-growth stands on sites where it originally occurred naturally.

Within the geographical range of the three important commercial species—white, green, and black ash—there are approximately 400,000,000 acres of woodland; but not over 4 per cent of this area has even a thin natural stand of ash such as would have an average increase by growth of, say, 10 board feet of ash per acre annually. This indicates that the maximum annual growth of ash to be expected in the United States is 160,000,000 feet, and the probability is that it will be considerably less. With the exhaustion of the virgin ash timber, therefore, it would be well, in order that the supply of ash may be maintained, to reduce the annual cut to something less than 150,000,000 feet, unless intensive forest management of the genus is undertaken on a considerable scale. This does not take into consideration, on the one hand, decrease in area of woodland

containing ash by clearing for agriculture, or, on the other, the possible influence of forest management in increasing the per acre growth of ash, factors which might be considered, to some extent at least, as counterbalancing each other.

CHARACTERISTICS OF ASH WOOD.

GENERAL DESCRIPTION OF THE WOOD.

Ash wood is heavy, strong, tough, stiff, and hard and takes a high polish. It shrinks only moderately in seasoning and bends well when seasoned. The layers of annual growth are clearly marked by several rows of large, open ducts occupying (in slow-growing specimens) nearly the entire width of the annual ring. The medullary rays are numerous and obscure. The color of the heartwood is brown; the sapwood is much lighter, often nearly white.

The proportion of heartwood and sapwood varies chiefly with the age of the tree. Old-growth ash trees, over 150 years in age, have a narrow rim of sap, usually less than 2 inches wide, and in black ash often less than 1 inch. (See Pl. VIII.) In second-growth ash less than 100 years in age the width of the sap, on trees over 12 inches in diameter, is usually from 3 to 6 inches, and forms by far the greater part of the lumber cut. Black-ash lumber, which usually is cut from very old, slow-growing trees, is mostly dark-colored heartwood, and the lumber for this reason is known commercially as brown ash. Over half of the white-ash and nearly all of the green-ash lumber is cut from trees less than 100 or 150 years in age and is mostly of the lighter color characteristic of sapwood.

Lumber from rapid-growing second-growth white and green ash is rather coarse grained and not especially attractive in figure. Lumber from slow-growing old growth, especially black ash, is finer grained and handsome in figure. Curly-ash lumber is occasionally cut, usually from black ash, and has an especially handsome figure.

The fuel value of dry-ash wood is, on the average, 81 per cent as high as hickory and 91 per cent as high as oak. Heavy sticks of ash frequently will equal oak in fuel value, especially blue, white, and green ash. In general, a cord of ash wood will give approximately the same heating value as 1 ton of high-grade coal.[1]

STRUCTURE.

Ash is a conspicuously ring-porous wood with numerous pores plainly visible to the naked eye in cross section. The structure, as it appears in transverse, radial, and tangential sections, is shown by Plate IV, figures 1, 2, and 3.[2] The annual ring is made conspicuous

[1] From figures compiled by H. S. Betts and Ernest Bateman, of the Forest Service.
[2] Photomicrographs of slides made by A. Koehler, of the Forest Products Laboratory.

by the contrast of the belt of springwood containing numerous large pores with that of the denser summerwood containing minute pores. The summerwood pores are arranged singly or in broken lines, the course of which is never radial. The pith or medullary rays are very minute and scarcely distinct when viewed in cross section, which is an important distinguishing characteristic of the genus, but one which is also characteristic of osage orange and catalpa, the woods that most closely resemble ash in structure. Osage-orange wood can be distinguished readily by its bright yellow color and by its very great hardness and weight. Catalpa wood, on the other hand, is light and soft and has the pores of its summerwood arranged in clusters, which is not the case in ash or osage orange.

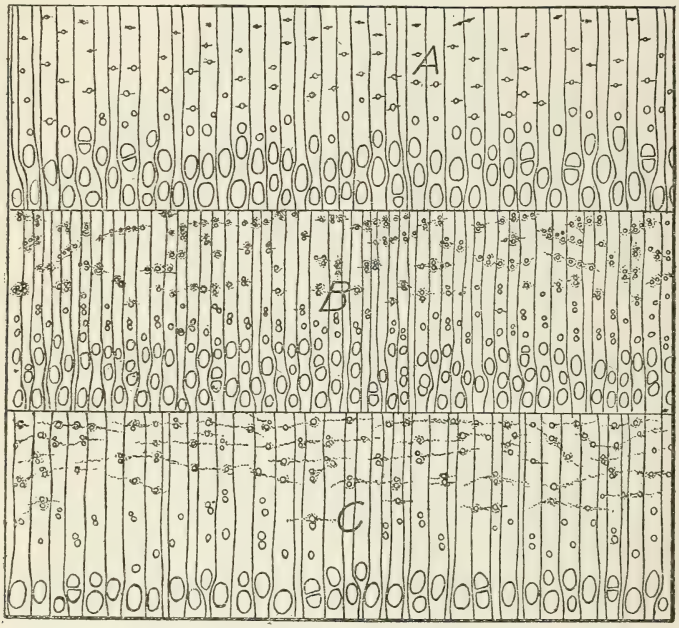


FIG. 3.—Transverse sections of ash wood under small hand lense; *A*, black ash; *B*, white ash; *C*, green ash. Taken from Bulletin 10 of the Division of Forestry (1895), by Prof. Filibert Roth.

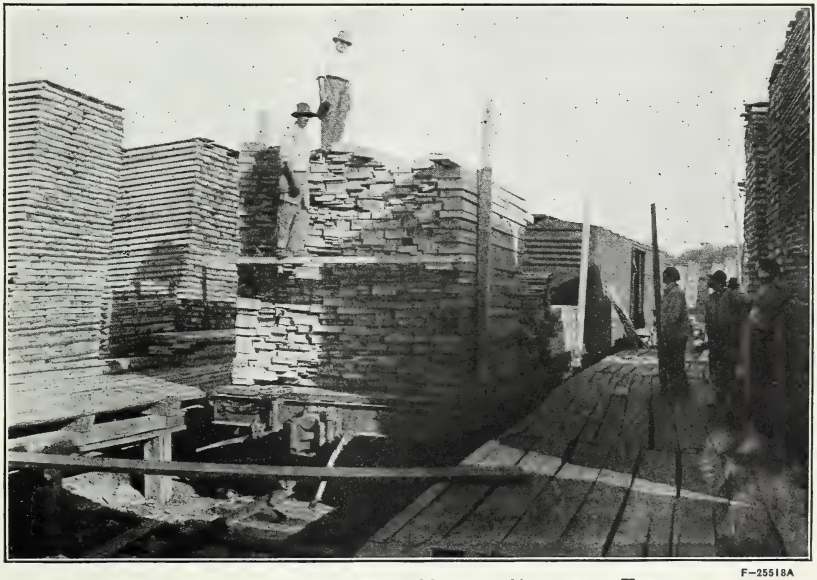
It is difficult and often impossible to distinguish, with any degree of certainty, the wood of the different species of ash. (Pls. V and VI.) Determination of species on the basis of wood characteristics, therefore, is very unsatisfactory. The following points of difference (fig. 3) in the important commercial series, as they appear under the magnifying glass, are taken from Forest Service Bulletin 10, "Timber," by Filibert Roth:[1]

[1] Photomicrographs of slides made by A. Koehler, of the Forest Products Laboratory.

F–25519A

FIG. 1.—WHITE ASH LOGS AT THE MILL. CENTRAL TENNESSEE.

The general run of ash logs are clear and straight but not large.



F–25518A

FIG. 2.—WHITE ASH LUMBER IN YARD AT NASHVILLE, TENN.

Note the predominance of dimension lumber.

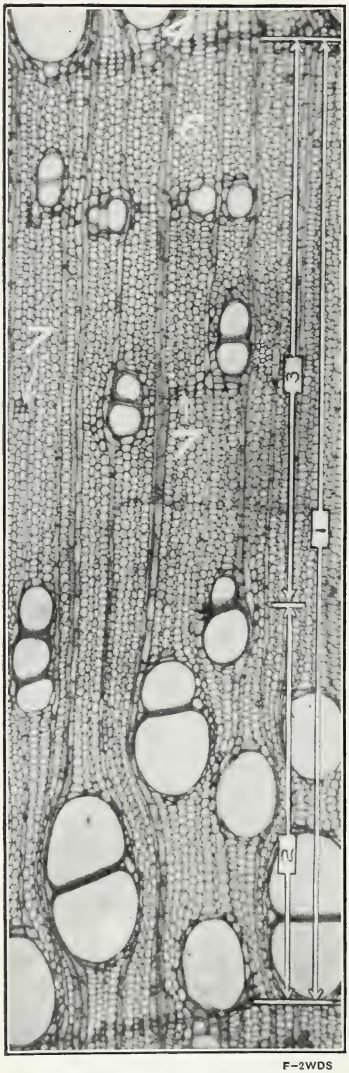


FIG. 1.—Transverse section.

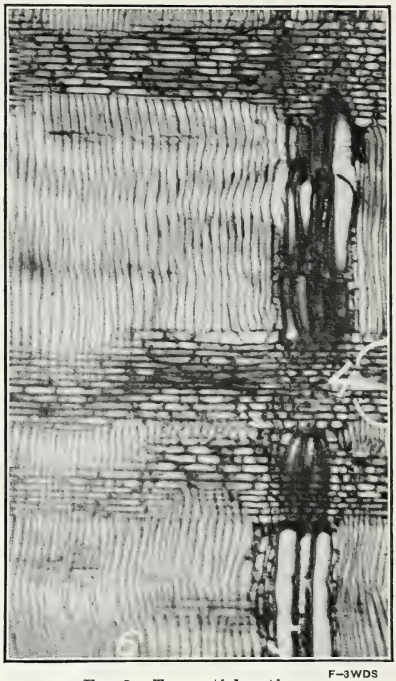


FIG. 2.—Tangential section.

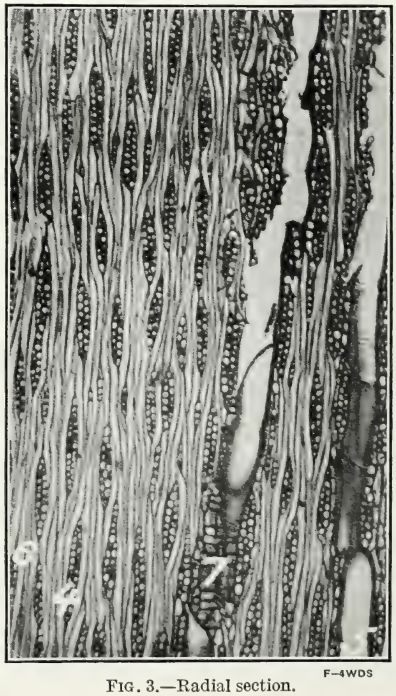


FIG. 3.—Radial section.

STRUCTURE OF WHITE ASH WOOD MAGNIFIED 50 DIAMETERS.

Numbers on photographs refer to the following: (1) Width of annual ring; (2) width of springwood; (3) width of summerwood; (4) medullary or pith ray; (5) vessel; (6) wood fiber; (7) wood parenchyma.

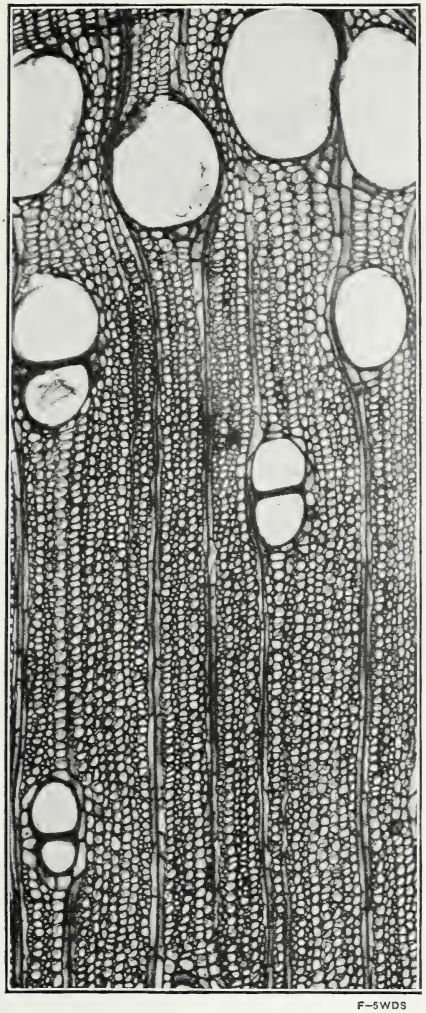


FIG. 1.—Pumpkin ash (*F. profunda*).

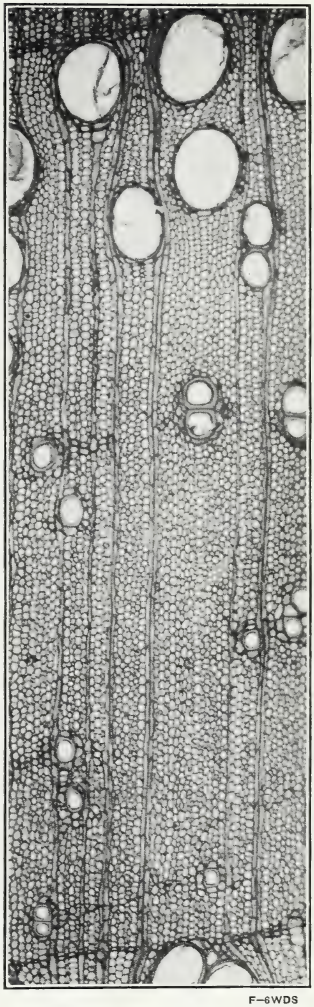


FIG. 2.—Blue ash (*F. quadrangulata*).

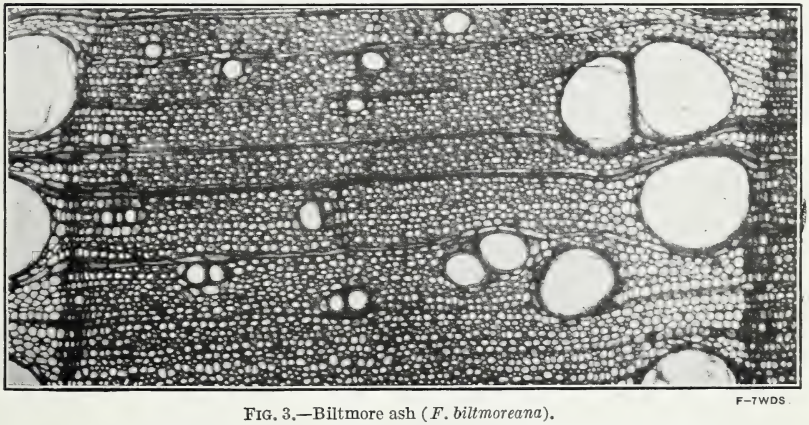


FIG. 3.—Biltmore ash (*F. biltmoreana*).

TRANSVERSE SECTIONS OF ASH WOOD, MAGNIFIED 50 DIAMETERS.

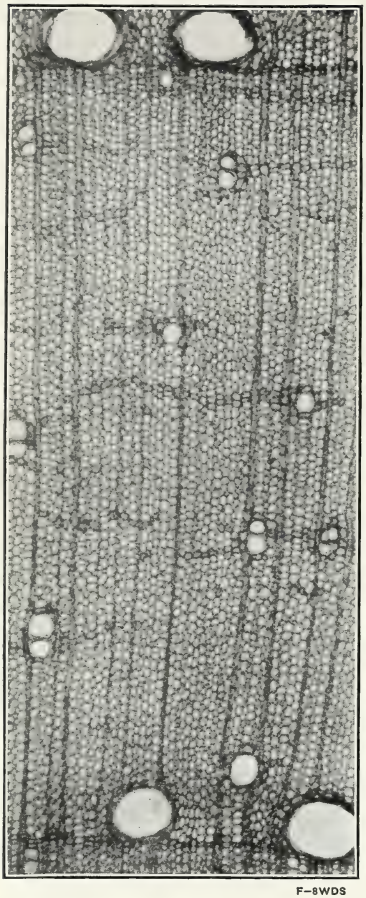


FIG. 1.—Water ash (*F. caroliniana*).

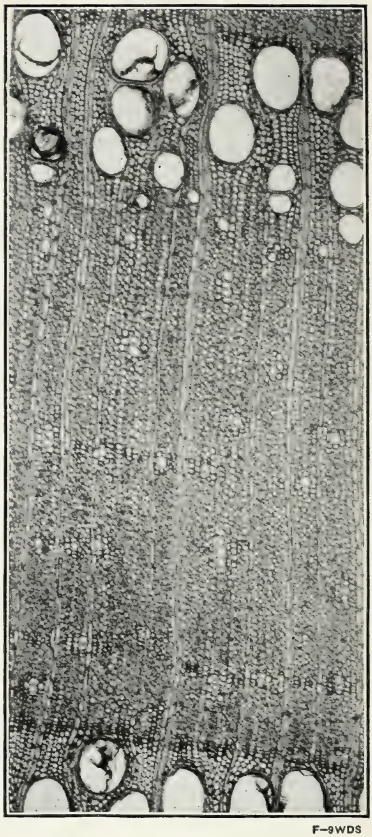


FIG. 2.—Blue ash (*F. quadrangulata*).

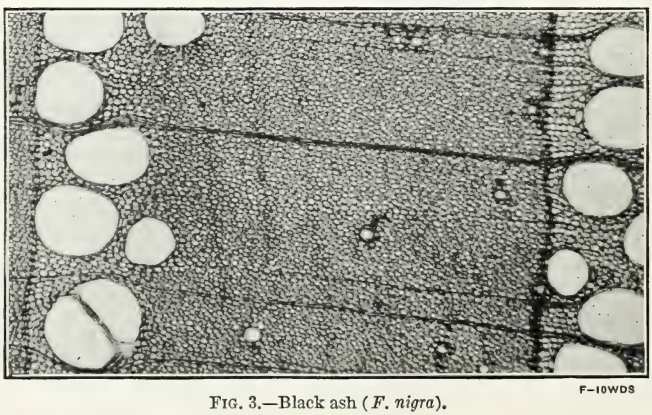


FIG. 3.—Black ash (*F. nigra*).

TRANSVERSE SECTIONS OF ASH WOOD, MAGNIFIED 50 DIAMETERS.

1. Pores in the summerwood more or less united in lines.
   a. The lines short and broken, occurring mostly near the limit of the ring ..... *White ash*
   b. The lines quite long and conspicuous in most parts of the summerwood ..... *Green ash*
2. Pores in the summerwood not united into lines, or rarely so.
   a. Heartwood reddish brown, and very firm ..... *Red ash*
   b. Heartwood grayish brown and much more porous ..... *Black ash*

MECHANICAL PROPERTIES OF THE DIFFERENT SPECIES.[1]

Table 10 gives the results of a large number of tests to determine the mechanical properties of different species of eastern ash from different parts of the country, and Table 11 gives a summary of them in general terms and in order of the relative strength of the different lots tested. Strength[2] is the most important property and therefore the factors which influence it are considered at length.

Specific gravity or weight.—The ashes follow the general law of timber in regard to the relations of mechanical properties and weight; i. e., all the mechanical properties increase in force as the specific gravity of the wood increases. This is not, however, always a straight line relation.

[1] By J. A. Newlin, of the Forest Products Laboratory.

[2] Bending strength and crushing strength, such as are important in beams and posts.

TABLE 10.—*Average physical and mechanical properties of green or air seasoned ash, based on tests of small clear specimens 2 by 2 in cross-section—bending 28-inch span.*

Species: Common and botanical name.	Locality where grown.	Number of trees.	Tree average.	Rings per inch.	Proportion of sap.	Moisture content.	Specific gravity oven dry. Based on—		Shrinkage from green to oven dry condition.			Static bending.					
							Volume when tested.	Volume when oven dry.	In volume.	Radial.	Tangential.	Fiber stress at elastic limit.	Modulus of rupture.	Modulus of elasticity.	Work in bending.		
															To elastic limit.	To maximum load.	Total.
														1,000			
GREEN.					*P. ct.*	*P. ct.*			*P. ct.*	*P. ct.*	*P. ct.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*lbs. per sq. in.*	*Inch lbs. per cu. in.*	*Inch. lbs. per cu. in.*	*Inch lbs. per cu. in.*
Biltmore ash (Fraxinus biltmoreana)	Overton County, Tenn.	5	Average	16.6	39.7	41.5	0.507	0.584	12.6	4.2	6.9	5,530	9,277	1,335	1.31	11.6	27.1
			Maximum	17.8	68.2	44.4	.550	.636	13.3	5.2	7.6	6,620	10,670	1,642	1.49	14.9	36.5
			Minimum	15.1	18.9	37.7	.473	.539	11.5	3.2	6.0	4,520	8,230	1,190	.97	9.6	16.5
Black ash (Fraxinus nigra)	Ontonagon County, Mich.	6	Average	23.1	3.0	90.6	.447	.526	15.2	5.0	7.8	2,610	6,000	1,107	.42	11.3	30.0
			Maximum	26.7	6.5	101.6	.490	.600	17.3	6.0	8.9	3,790	7,990	1,431	.60	18.2	39.6
			Minimum	18.5	1.2	75.3	.402	.430	13.9	4.0	6.9	1,840	4,290	798	.24	6.2	16.8
Blue ash (Fraxinus quadrangulata)	Bourbon County, Ky	5	Average	12.5	87.7	39.3	.533	.603	11.7	3.9	6.5	5,700	9,650	1,241	1.47	14.7	40.1
			Maximum	15.5	100.0	41.0	.568	.647	13.2	4.5	7.5	6,640	10,350	1,366	1.79	17.6	46.8
			Minimum	9.8	72.7	38.2	.480	.536	10.4	3.2	5.6	4,780	8,190	1,091	1.18	10.3	30.9
Green ash (Fraxinus lanceolata)	Richland Parish, La.	5	Average	20.6	68.1	47.4	.516	.....	.....	.....	.....	4,450	8,880	1,319	.87	10.6	24.0
			Maximum	24.8	90.2	48.5	.531	.....	.....	.....	.....	5,010	9,520	1,459	1.29	12.0	26.6
			Minimum	15.5	53.3	45.2	.504	.....	.....	.....	.....	3,860	8,390	1,127	.65	9.0	20.9
Green ash (Fraxinus lanceolata)	New Madrid County, Mo.	5	Average	13.7	57.1	48.3	.534	.631	13.3	4.6	7.1	6,110	10,040	1,480	1.42	13.0	32.7
			Maximum	20.0	95.7	52.0	.566	.669	14.2	5.0	8.4	6,960	11,120	1,721	1.72	15.9	48.0
			Minimum	9.4	21.9	42.6	.463	.556	11.9	3.6	5.4	4,380	7,480	1,023	1.07	9.0	13.6
Pumpkin ash (Fraxinus profunda)	New Madrid County, Mo.	3	Average	21.0	48.5	51.4	.485	.551	12.0	3.7	6.3	4,470	7,600	1,043	1.08	9.4	18.7
			Maximum	24.5	50.0	53.8	.523	.600	12.6	4.0	7.5	5,550	8,890	1,263	1.37	12.1	35.6
			Minimum	17.7	46.0	48.7	.450	.504	11.2	3.2	5.4	3,760	6,590	855	.93	7.5	.....
White ash (Fraxinus americana)	Stone County, Ark.	5	Average	14.8	61.0	38.2	.550	.640	12.6	4.3	6.4	5,180	9,920	1,416	1.10	20.0	43.7
			Maximum	17.6	89.2	41.4	.606	.739	15.5	5.9	9.0	6,180	11,850	1,971	1.23	27.3	54.6
			Minimum	11.4	29.9	36.7	.498	.550	9.6	3.1	4.7	4,490	8,670	1,104	.95	15.6	29.8

White ash (Fraxinus americana).....	Oswego County, N. Y...	5	Average...	8.8	54.8	40.3	.582	.708	14.0	5.3	8.7	6,140	10,760	1,635	1.30	16.3	41.2
			Maximum.	11.4	91.2	42.0	.606	.773	15.0	5.8	9.6	6,890	12,020	1,842	1.46	19.6	51.2
			Minimum.	6.1	23.3	38.8	.526	.677	12.4	4.6	7.4	5,640	9,860	1,398	1.23	13.7	30.5
White ash (Fraxinus americana)....	Pocahontas County, W. Va.	5	Average...	17.2	10.6	48.1	.495	.559	12.6	4.1	6.6	4,600	8,310	1,285	.96	13.6	32.8
			Maximum.	23.1	19.5	52.9	.528	.588	14.2	4.8	7.6	5,340	9,120	1,407	1.15	16.7	44.6
			Minimum.	11.4	00.0	43.5	.460	.530	11.0	3.4	5.7	4,060	7,130	1,074	.83	10.8	18.4
AIR SEASONED.																	
Biltmore ash (Fraxinus biltmoreana).	Overton County, Tenn..	....	Average...	16.6	39.7	5.4	.586	.....	.....	.....	.....	12,110	15,560	1,760	4.60	11.7	13.4
Black ash (Fraxinus nigra).....	Ontonagon County, Mich.	....	Average...	23.1	3.0	9.1	.500	.....	.....	.....	.....	10,340	16,130	1,975	2.05	17.9	38.6
Blue ash (Fraxinus quadrangulata)..	Bourbon County, Ky...	....	Average...	12.5	8.7	9.6	.575	.....	.....	.....	.....	8,720	14,770	1,433	3.00	14.3	33.7
Green ash (Fraxinus lanceolata).....	Richland Parish, La....	....	Average...	20.6	68.1	11.2	.552	.....	.....	.....	.....	8,950	13,680	1,615	2.82	12.6	21.5
Green ash (Fraxinus lanceolata).....	New Madrid County, Mo.	....	Average...	13.7	57.1	9.6	.588	.....	.....	.....	.....	9,970	16,110	1,768	3.18	14.6	21.9
Pumpkin ash (Fraxinus profunda)..	New Madrid County, Mo.	....	Average...	21.0	48.5	9.6	.514	.....	.....	.....	.....	6,980	11,810	1,312	2.11	7.8	12.5
White ash (Fraxinus americana)....	Stone County, Ark.....	....	Average...	14.8	61.0	10.5	.609	.....	.....	.....	.....	10,770	17,650	1,942	3.42	14.8	36.2
White ash (Fraxinus americana)....	Oswego County, N. Y...	....	Average...	8.8	54.8	9.5	.637	.....	.....	.....	.....	13,010	18,650	1,985	4.80	17.0	26.9
White ash (Fraxinus americana)....	Pocahontas County, W. Va.	....	Average...	17.2	10.6	6.9	.554	.....	.....	.....	.....	9,580	15,960	1,684	3.16	13.4	26.2

TABLE 10.—*Average physical and mechanical properties of green or air seasoned ash, based on tests of small clear specimens 2 by 2 in cross-section—bending 28-inch span*—Continued.

Species: Common and botanical name.	Locality where grown.	Number of trees.	Tree average.	Impact bending.				Compression parallel to grain.			Compression perpendicular to grain.	Hardness. Load required to imbed a 0.444-inch ball to one-half its diameter.			Shearing strength parallel to grain.		Cleavage strenght per inch of width.		Tension perpendicular to grain.	
				Fiber stress at elastic limit.	Modulus of elasticity.	Work in bending to elastic limit.	Height of drop causing complete failure—50-pound hammer.	Fiber stress at elastic limit.	Crushing strength.	Modulus of elasticity.	Fiber stress at elastic limit.	End surface.	Radial surface.	Tangential surface.	When surface of failure is—					
															Radial.	Tangential.	Radial.	Tangential.	Radial.	Tangential.
GREEN.				*Lbs. per sq. in.*	*1,000 lbs. per sq. in.*	*Inch lbs. per cu. in.*	*Ins.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*1,000 lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Lbs.*	*Lbs.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*
Biltmore ash (Fraxinus biltmoreana).	Overton County, Tenn.	5	Average...	11,930	1,657	4.9	30	3,560	3,980	1,488	875	953	838	868	1,260	1,205	333	353	507	564
			Maximum.	15,590	1,974	6.8	41	4,420	4,870	1,731	980	1,060	961	1,064	1,482	1,538	394	525	554	673
			Minimum.	10,290	1,427	4.2	20	2,900	3,270	1,298	715	781	662	691	1,072	1,005	300	273	443	480
Black ash (Fraxinus nigra).	Ontonagon County, Mich.	6	Average...	7,230	1,182	2.5	35	1,620	2,340	1,120	409	610	546	559	884	849	307	225	519	461
			Maximum.	8,960	1,558	2.9	56	2,430	3,080	1,462	456	741	696	660	956	1,030	327	255	569	562
			Minimum.	5,650	979	1.9	24	1,060	1,730	830	341	501	447	448	770	734	275	183	464	383
Blue ash (Fraxinus quadrangulata).	Bourbon County, Ky.	5	Average...	11,140	1,394	5.0	43	3,540	4,180	1,308	994	1,140	1,013	1,043	1,558	1,529	308	398	507	660
			Maximum.	12,730	1,489	6.1	58	3,810	4,490	1,602	1,195	1,288	1,232	1,247	1,785	1,850	361	451	680	764
			Minimum.	10,010	1,271	4.0	29	3,100	3,600	1,000	840	983	775	822	1,375	1,303	259	360	395	478
Green ash (Franxius lanceolata).	Richland Parish, La.	5	Average...	11,720	1,388	5.6	32	3,210	4,040	1,497	801	842	729	734	1,239	1,166	357	341	616	611
			Maximum.	12,020	1,506	5 9	39	3,700	4,160	1,700	868	889	780	894	1,361	1,258	390	424	837	721
			Minimum.	11,250	1,186	5.2	28	2,810	3,880	1,262	740	779	651	645	1,153	1,090	284	244	475	427
Green ash (Fraxinus lanceolata).	New Madrid County, Mo.	5	Average...	11,150	1,571	4.4	37	3,920	4,360	1,545	1,012	1,073	977	1,037	1,332	1,305	329	361	553	574
			Maximum.	12,290	1,833	5.0	44	4,380	4,710	1,799	1,101	1,211	1,132	1,279	1,433	1,416	352	430	606	623
			Minimum.	7,720	944	3.5	22	2,890	3,300	1,204	937	880	750	757	1,204	1,164	280	328	493	483

Pumpkin ash (Fraxinus profunda).	New Madrid County, Mo.	3	Average...	8,760	1,204	3.7	31	2,830	3,360	1,098	989	885	772	733	1,229	1,199	337	377	587	561
			Maximum.	10,720	1,438	4.6	42	3,580	3,950	1,391	1,155	1,007	985	955	1,356	1,288	359	428	643	766
			Minimum.	7,590	972	2.7	24	2,360	2,940	864	851	798	632	578	1,117	1,089	302	334	521	416
White ash (Fraxinus americana).	Stone County, Ark.	5	Average...	11,710	1,564	4.9	33	3,510	4,220	1,531	889	1,121	1,000	1,017	1,360	1,312	333	346	645	671
			Maximum.	15,280	2,095	6.2	47	4,240	5,120	2,410	943	1,262	1,212	1,262	1,471	1,430	408	384	738	792
			Minimum.	8,480	1,116	3.6	19	2,880	3,720	1,115	800	919	784	750	1,139	1,184	254	291	520	619
White ash (Fraxinus americana).	Oswego County, N. Y.	5	Average...	13,780	1,784	5.9	47	3,820	4,630	1,720	794	1,145	1,088	1,078	1,600	1,609	392	488	697	877
			Maximum.	15,700	2,110	6.6	54	4,500	5,170	2,040	988	1,179	1,194	1,195	1,732	1,770	429	535	866	955
			Minimum.	10,840	1,436	4.6	36	3,150	3,960	1,437	559	1,110	935	995	1,403	1,393	344	440	505	772
White ash (Fraxinus americana).	Pocahontas County, W. Va.	5	Average...	11,620	1,490	5.1	38	2,950	3,390	1,465	705	872	789	781	1,204	1,162	303	368	546	634
			Maximum.	12,390	1,696	6.0	46	3,510	3,710	1,747	810	948	892	927	1,289	1,243	336	424	748	702
			Minimum.	10,080	1,284	4.4	32	2,390	2,950	1,029	611	790	685	644	1,076	1,043	269	340	440	546
AIR SEASONED.																				
Biltmore ash (Fraxinus biltmoreana).	Overton County, Tenn.	....	Average ..	19,850	2,150	10.4	46	7,140	10,370	2,045	2,020	2,060	1,395	1,265	2,120	1,825	449	456	864	762
Black ash (Fraxinus nigra).	Ontonagan County, Mich.	....	Average...	.....	2,276	.....	44	6,300	8,190	2,015	1,270	1,398	897	1,090	1,997	1,592	366	428	585	935
Blue ash (Fraxinus quadrangulata).	Bourbon County, Ky.	....	Average...	20,550	2,245	10.5	42	6,120	7,735	1,394	1,911	1,893	1,374	1,338	1 990	2,316	404	505	467	.....
Green ash (Fraxinus lanceolata).	Richland Parish, La.	....	Average...	15,850	1,910	7.3	32	4,750	7,300	1,825	1,292	1,676	1,196	1,110	1,910	1,755	314	425	755	616
Green ash (Fraxinus lanceolata).	New Madrid County, Mo.	....	Average...	18,900	2,210	9.0	30	5,910	7,850	2,133	2,220	1,870	1,428	1,296	2,361	2,312	582	545	786	693
Pumpkin ash (Fraxinus profunda).	New Madrid County, Mo.	....	Average...	15,150	1,697	7.9	22	4,035	6,340	1,185	1,995	1,535	1,031	1,021	2,028	1,758	514	404	1,020	636
White ash (Fraxinus americana).	Stone County, Ark.	....	Average...	14,920	1,930	6.5	34	6,110	7,900	1,870	1,315	2,065	1,486	1,345	2,300	2,130	680	496	1,055	682
White ash (Fraxinus americana).	Oswego County, N. Y.	....	Average...	23,840	2,490	12.8	46	8,530	9,260	2,080	2,090	2,240	1,568	1,792	2,540	2,510	506	436	1,255	1,000
White ash (Fraxinus americana).	Pocahontas County, W. Va.	....	Average...	19,050	1,932	11.0	37	5,140	8,480	1,940	1,762	1,833	1,208	1,240	2,215	1,802	391	228	945	849

TABLE 11.—*Physical and mechanical properties of ash of different species from different localities.*

[Expressed in general terms [1] for comparison with other species, and in numbers denoting their relative values for comparison with each other, giving white ash from New York the value of 100 as a standard, together with description of sites from which the materials tested were secured.]

Species and locality.	Weight.	Strength as a beam or post.	Hardness.	Shock-resisting ability.	Stiffness.	Shrinkage.	Rings per inch of test pieces.	Number and age of trees from which test pieces were taken.
White ash, New York (fresh to moist upland, sandy loam, elevation 300 feet).	Heavy (100)...	Very strong (100).	Hard (100)....	Excellent (100).	Stiff (100).....	Moderate (100).	6.1 to 11.4, average 8.8.	5 trees, 50 to 68 years, average 60 years.
White ash, Arkansas (limestone upland, fresh to moist, Ozark Hills, far to the west of the best region of the species' occurrence).	Heavy (94)....	Strong (89)....	Hard (93).....	Good (95).....	Stiff (91).....	Very moderate (90).	11.4 to 17.6, average 14.8.	5 trees, 90 to 122 years, average 104 years.
Green ash, Missouri (rich overflow bottom land, dry during growing season).	Heavy (91.8)..	Strong (89)....	Hard (100)....	Good (79).....	Stiff (92).....	Very moderate (95).	9.4 to 20, average 13.7.	5 trees, 90 to 210 years, average 140 years.
Blue ash, Kentucky (limestone blue grass hills, from open pastured forest, which should produce unusually tough, strong wood).	Heavy (91.6)..	Strong (95)....	Hard (99).....	Good (92).....	Moderately stiff (78).	Very moderate (84).	9.8 to 15.5, average 12.5.	5 trees, 150 to 190 years, average 170 years.
Green ash, Louisiana (bottom land too wet for best growth until comparatively recently).	Heavy (89)....	Strong (81)....	Hard (78).....	Moderately good (67).	Moderately stiff (84).	.....	15.5 to 24.8, average 20.6.	5 trees, 125 to 193 years, average 171 years.
Biltmore ash, Tennessee (Upland, fresh to dry stony loam, limestone rock underlying; dense forest).	Heavy (87)....	Strong (84)....	Hard (85).....	Good (69).....	Stiff (87).....	Very moderate (90).	15.1 to 17.8, average 16.6.	5 trees, 150 to 220 years, average 188 years.
Oregon ash, Oregon (rich alluvial sandy mountain valley soil; dense forest).	Heavy.....	.....	.....	.....	.....	.....	9.9 to 15.6, average 12.4.	3 trees, 105 to 135 years, average 123 years.
White ash, West Virginia (steep north slopes 3,500 feet elevation, thin, moist, clay loams).	Moderately heavy (85).	Moderately strong (75).	Hard (76).....	Good (82).....	Moderately stiff (83).	Very moderate (90).	11.4 to 23.1, average 17.2.	5 trees, 160 to 300 years, average 200 years.
Pumpkin ash, Missouri (bottom land, wet and swampy land till comparatively recently).	Moderately heavy (83).	Moderately strong (67).	Hard (86).....	Moderately good (56).	Moderately limber (66).	Moderately small (86).	17.7 to 24.5, average 21.	3 trees, 180 to 230 years, average 210 years.
Black ash, Michigan (cold, wet, swampy land, short growing season, and slow growth).	Moderately heavy (77).	Moderately weak (62).	Moderately hard (54).	Good (79).....	Moderately stiff (76).	Moderate (109).	18.5 to 26.7, average 23.1.	6 trees, 170 to 230 years, average 210 years.

[1] See key for classification of terms used in describing physical and mechanical properties of woods grown in the United States in the Appendix, pp. 49 to 52.

Rate of growth.—Generally speaking, rapid-growing ash trees produce better timber than slow-growing trees; the more rapid the growth the greater the density and the better the quality of the timber.[1] Nevertheless, perfectly thrifty trees grown under widely varying conditions, especially of moisture, will probably show a large difference in rate of growth, with practically no difference in density or mechanical properties. This is known to be true of other species, but data determined are not sufficient to verify it with regard to the ashes.

Position in tree.—The toughest material appears to be at the butt, and the material strongest as a beam or upright is found higher in the tree. As to position in cross section, the timber of best quality appears to be from 3 to 7 inches from the center of the tree, the quality gradually becoming poorer as the distance from the center increases. Suppressed or slow growth in early life, followed by rapid growth in later life, may upset this relation, and the best material may be found in the outer portion of an old tree. The value of the timber in any portion of the cross section depends on its specific gravity.

Age.—Since the mechanical powers show a gradual decrease in the wood outside of 7 inches from the center, old trees (or those of large diameter) would average weaker than the younger trees. However, this is by no means an infallible rule. An ash tree of any age which is perfectly healthy and not suppressed is probably putting on wood of high mechanical value. Any circumstances causing the vigor of the tree to decrease would probably cause it to put on inferior wood.

Heart and sap.—The results of tests fail to show that any difference is caused in the mechanical properties by a change from sap to heart. In most mature trees the heartwood is stronger, tougher, and has better shock-resisting ability than the sapwood. On the other hand, in young trees with a very small proportion of heart, the reverse is normally true. The density of the wood is the criterion which indicates which is the better in any particular instance. In trees of equal age and of the same rate of growth but having widely different proportions of sap, those with the larger proportion of sap were not found to be superior to those containing less sap. The data show without doubt that the grading should be on the basis of density and that the percentage of sap should be ignored entirely.

Locality.—It is probably immaterial in what section of country the timber is grown. The thing to be sought is dense, strong wood. This is best obtained from rapid-growing, comparatively young, small to

[1] Rapid growth, however, is not the reason for better quality, but rather it is the general vigor of the tree which results in density of wood as well as rapidity of growth.

medium sized trees. The silvicultural conditions for growing such trees are a good soil and abundant growing space.

Species.—Table 10 indicates that distinction between species is of little importance in judging mechanical values. Thus while one lot of white ash was the best of any tested, two other lots ranked below one of green ash.

With the exception of black ash, which will be considered later, the differences in mechanical properties of the various species of ash are the same as would be expected in trees of the same species with varying specific gravities. In general, however, ash species growing under natural conditions will rank about as follows in relative strength as a beam or post: White ash, green ash, blue ash, Biltmore ash, pumpkin ash, black ash. Pumpkin ash and black ash usually are found growing under unfavorable conditions (wet swamps and slow growth) for putting on dense wood; while white, blue, and Biltmore ash occur naturally on more favorable sites; green ash occurs about half on sites with defective drainage and half on sites where the drainage is sufficient, but always on rich alluvial soil. (See Pls. VII, VIII, and IX.)

A further classification of the relative strength of the different species, of importance to future growers of ash timber, may be made on the basis of uniformly fast growing, small to medium sized trees, growing under favorable conditions, such as would be secured under proper management. From this standpoint the species probably would rank as follows: White ash, green ash, Biltmore ash, blue ash, and black ash. It would be hard to say whether pumpkin ash would precede or follow blue ash, where grown under favorable conditions. This ranking of species is based on Table 10, consideration being given at the same time to rate of growth (rings per inch), age (or size), character of site, and the conditions given in Table 11. These factors account for apparent variations in the relative strength of the different species. Thus the blue ash in the table has a relatively high rank because of the unusually favorable conditions for putting on dense wood under which the specimen trees grew—all the trees were predominant and grew in an open stand on limestone soil. It will be seen, also, that the blue ash falls below green ash of Missouri in strength, although equalling it in weight and having fewer rings per inch. Black ash, on the other hand, if grown under favorable conditions, might reasonably be expected to produce much stronger timber than the table indicates—nearly equal to blue ash, to which it is botanically closely related.

The tests on black ash in the green condition indicated almost double as much moisture content as the tests on any of the other ashes. Black ash is the lightest of the ashes tested, is very weak,

FIG. 1.—DISK FROM A SUPPRESSED WHITE ASH, 85 YEARS OLD, THE LUMBER FROM WHICH WOULD NOT BE VERY STRONG. CENTRAL NEW YORK.

FIG. 2.—GREEN ASH, 50 YEARS OLD, FROM ROANOKE RIVER, N. C.

Fairly rapid growth and strong wood.

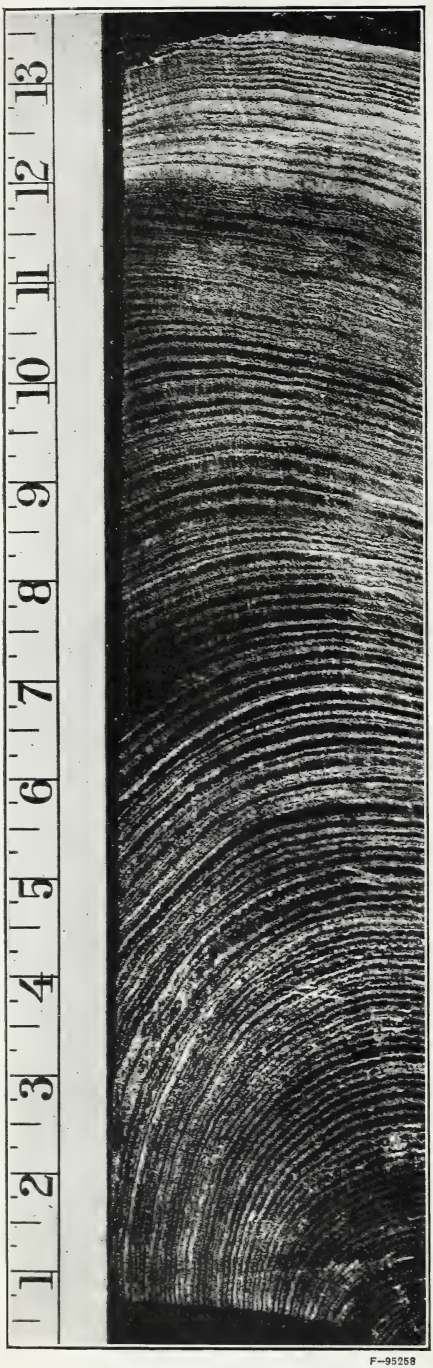


FIG. 1.—Black ash, 220 years old, from northern Michigan. Nearly all heartwood. Tree 24 inches in diameter breasthigh.

FIG. 2.—Green ash, 90 years old, the same size as the black ash in figure 1. From southeastern Missouri. Mostly sapwood. Much stronger than the black ash.

DISKS SHOWING MAXIMUM RATE OF GROWTH OF BLACK AND GREEN ASH, AND PROPORTION OF HEARTWOOD AND SAPWOOD.

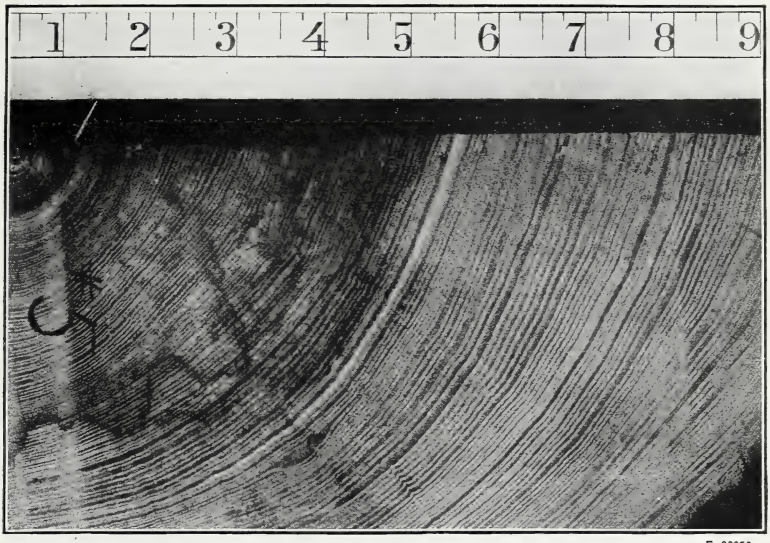


FIG. 1.—DISK FROM 185-YEAR-OLD PUMPKIN ASH FROM SOUTHEASTERN MISSOURI.
Slow growth and not strong for ash.

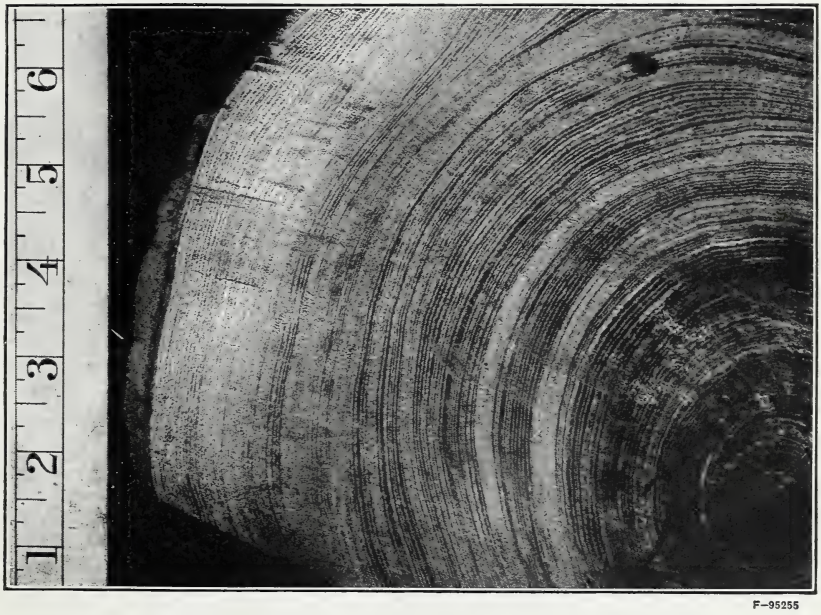
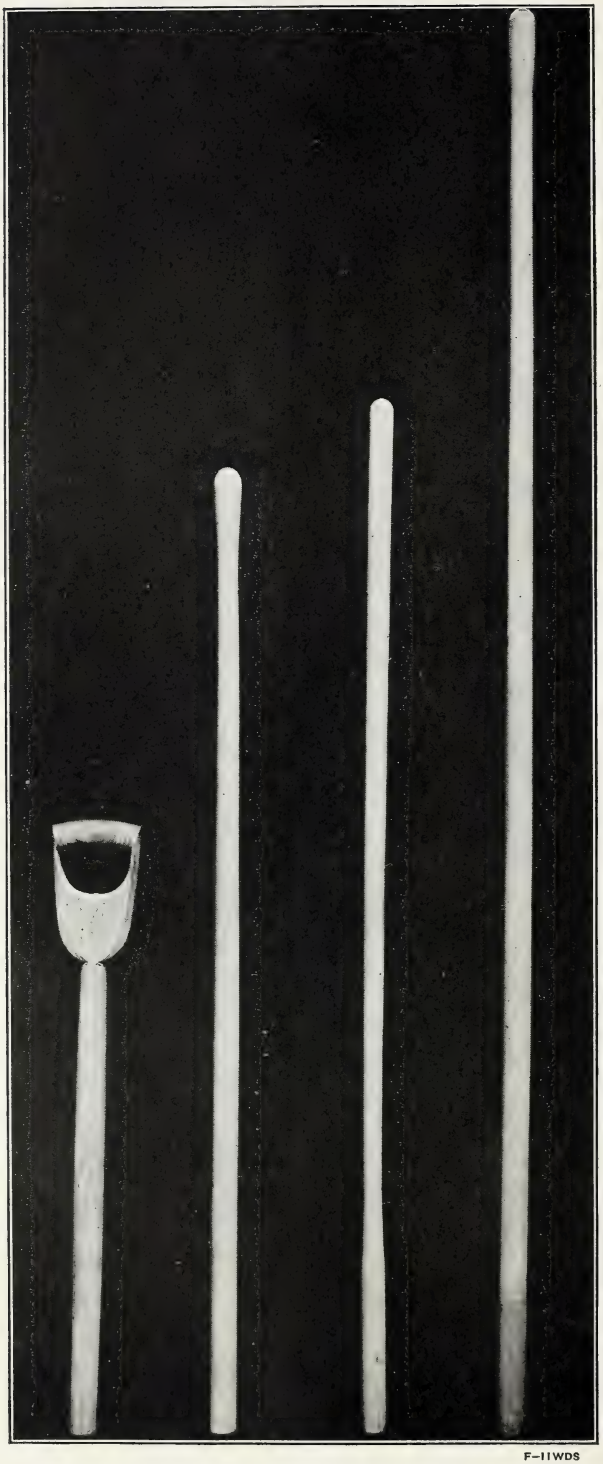


FIG. 2.—DISK FROM 200-YEAR-OLD BLACK ASH FROM NORTHERN MICHIGAN.
Very slow growth and weak wood for ash.



F-11WDS

GOOD QUALITY STRAIGHT-GRAINED ASH HANDLES OF THE KIND CHIEFLY MADE FROM ASH.

From left to right: Shovel, fork, hoe, and hayfork handles.

especially in the green condition, and is much the toughest. It showed a remarkable gain in crushing and bending strength as a result of seasoning, and in shock-resisting ability ranks well with the denser species. With but few exceptions, the shrinkage of timber varies directly with the specific gravity. Black ash is one of these exceptions. It has about the same shrinkage as the best grade of white ash, about 25 per cent greater than would be expected for a species of equal specific gravity. For making baskets, hoops, and the like, the peculiar properties of black ash make it rank first among the ashes.

SEASONING.

Ash lumber seasons rapidly, in this respect ranking about as follows with the other common woods, commencing with the most rapid: Red spruce, white ash, red gum, yellow birch, sugar maple, walnut, white oak. This matter of the rate of seasoning is important in connection with rate of increase or decrease in size of lumber when exposed to change in atmospheric conditions, as it is reasonable to assume that those woods which dry most readily are the ones which respond most quickly to the effects of varying conditions, which is not a desirable quality in wood.

In shrinkage from green to oven-dry condition, white ash compares as follows with other species:

	In volume.	Radially.	Tangentially.
	Per cent.	*Per cent.*	*Per cent.*
Ash (white)	13.1	4.8	7.2
Birch (yellow)	16.8	7.4	9.0
Cherry (black)	11.5	3.7	7.1
Gum (red)	16.9	5.3	11.4
Maple (sugar)	14.5	4.8	9.2
Oak (white)	15.8	5.4	9.0
Spruce (red)	11.8	3.8	7.8
Walnut (black)	11.3	5.2	7.1

In a properly operated kiln, ash can be very easily kiln-dried from the green condition with even less checking than would occur in preliminary air seasoning; and for most uses ash is ultimately kiln-dried. It is doubtful whether kiln-dried ash stock would work (shrink and swell) more with changes of atmospheric conditions than that which has been air-dried and then kiln-dried.

CHEMICAL PROPERTIES.

Ash wood consists of a skeleton of cellulose, permeated with a mixture of other organic substances common to hardwoods. "One hundred pounds of wood as sold in the wood yards contains in round numbers 25 pounds of water, 74 pounds of wood, and 1 pound of

ashes. The 74 pounds of wood are composed of 37 pounds of carbon (charcoal), 4.4 pounds of hydrogen, and 32 pounds of oxygen."[1]

DURABILITY IN CONTACT WITH THE GROUND.

Ash wood is only moderately durable in contact with the ground. It is used to a minor extent for posts, rails, and gate bars in localities where better timber is not available. White and green ash are as durable as red oak, butternut, and red elm; while black ash is considerably more so because of its large per cent of heartwood, which is due to slow growth. White and green ash are more durable than aspen, basswood, box elder, cottonwood, hard and soft maples, hickory, white elm, and willow, and are preferable to these trees for untreated fence posts. Fence posts from these two ashes will last from 6 to 12 years, depending on size, percentage of heartwood, method of seasoning, the character of the site in which the post is set, and the season of the year when the tree is cut. Black ash posts will usually last from 12 to 15 years.

DISEASES AND INSECTS WHICH ATTACK ASH TIMBER.

Standing ash timber is not subject to extensive damage by disease. Although a number of diseases have been found on the different species of ash, only one has done much serious harm, white rot. Diseased trees are mostly those whose vitality has been weakened by old age, fire, or generally adverse conditions.

White rot occurs in the heartwood of the trunk and main branches, and is caused by the fungus *Polyporus fraxinophilus*, which turns the wood into a mass of yellow pulp. This disease is common in overmature green ash in the lower Ohio Valley and in the Mississippi River bottoms, near their confluence; it is also common on white ash near the western limit of its range in Iowa, Missouri, Kansas, and Oklahoma, where it occurs on dry limestone hills and where 90 per cent of the trees are infected.[2]

The two insects which are of primary importance in connection with ash products are: (1) the ash wood borer (*Neoclytus capraea*) which attacks the logs and bolts from trees felled in the late fall, winter, and early spring, and destroys the sapwood; and, (2) the Lyctus powder post beetle which attacks the sapwood of products after they have been seasoned for a year or more. The Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C., has made special studies of these insects and has discovered practical

[1] From Bulletin 10 of the Division of Forestry, Department of Agriculture, "Timber: Elementary Discussion of Characteristics and Properties of Wood," by Filibert Roth.

[2] Full discussion of this disease is contained in Bulletin No. 32 of the Bureau of Plant Industry, "A Disease of the White Ash Caused by *Polyporus fraxinophilus*.

methods of preventing losses from them through proper handling of logs and lumber. In addition to its publications on the subject, the Bureau of Entomology will supply information by correspondence when special cases are reported to it.

UTILIZATION BY INDUSTRIES.

Practically all of the cut of ash lumber, as given in the United States census reports, is consumed in different wood-using industries. The high value and the scarcity of the wood preclude the use of ash lumber in general construction work.

The uses to which ash is put may be conveniently grouped by the industries. This is done in Table 12, which indicates for each industry the amount of ash material and the proportion of the total that is used, the average price paid for material delivered at the factory, and the total cost of material. In round numbers, 22 per cent of the ash used in industries goes into handles; 20 per cent into butter-tub staves and headings; 15 per cent into vehicles, including automobiles; 7 per cent into planing-mill products; 6 per cent each into refrigerators and kitchen cabinets, furniture (including chairs and chair stock), and car construction; 3 per cent into boxes and crates, agricultural implements, and ships and boats (chiefly oars); 1 per cent each into sporting and athletic goods, fixtures, musical instruments, woodenware and novelties, and hames; and from one-quarter to one-half of 1 per cent into machine construction, pumps, sucker rods, toys, and tanks. A total of about 1 per cent of the ash used goes into plumbers' woodwork, trunks, pulleys and conveyors, picker sticks, printing materials, picture frames and molding, and carpet sweepers. The remainder, comprising less than one-half of 1 per cent, goes into playground equipment, rollers for shades and maps, elevators, professional and scientific instruments, laundry appliances, machinery and electrical apparatus, mine equipment, brushes, patterns and flasks (for foundry work), whips, canes, umbrella sticks, dowels, caskets and coffins, butcher's blocks, aeroplane frames and propellers, weighing apparatus, and gates and fencing.

TABLE 12.—*Use of ash by secondary wood-using industries in the United States.*

Use.	Quantity used annually.		Average cost per 1,000 feet.	Total cost f. o. b. factory.
	Feet b. m.	Per cent.		
(1) Handles	64,156,872	21.72	$29.88	$1,917,033.40
(2) Dairy supplies (chiefly butter tub staves and heading)	60,285,800	20.40	25.43	1,532,876.00
(3) Vehicles and vehicle parts	43,974,668	14.88	42.77	1,880,588.30
(4) Planing-mill products, sash, doors, and blinds, and general mill work	21,304,374	7.21	31.39	668,716.25
(5) Refrigerators and kitchen cabinets	19,066,380	6.45	29.41	560,812.31
(6) Car construction	18,163,433	6.15	49.83	905,158.00
(7) Furniture	15,668,588	5.30	27.21	426,270.56
(8) Agricultural implements	10,677,400	3.61	40.05	427,638.00
(9) Boxes and crates	10,507,308	3.56	14.40	151,257.53
(10) Ship and boat building (chiefly boat oars)	7,985,554	2.70	29.26	233,621.41
(11) Sporting and athletic goods	3,180,000	1.08	34.68	110,293.00
(12) Fixtures	2,783,822	.94	37.16	103,446.00
(13) Chairs and chair stock	2,765,050	.94	27.19	75,190.50
(14) Instruments, musical	2,377,332	.81	53.17	126,399.00
(15) Woodenware and novelties	2,350,000	.80	28.83	67,750.50
(16) Saddles and harness (chiefly harness)	2,103,000	.71	35.18	73,992.00
(17) Machine construction	1,404,362	.48	44.34	62,262.66
(18) Pumps (mostly sucker rods)	975,500	.33	19.41	18,935.00
(19) Toys	895,300	.30	33.22	29,740.00
(20) Tanks	866,000	.29	32.56	28,194.00
(21) Plumbers' woodwork	536,000	.18	24.99	13,395.00
(22) Trunks	534,435	.18	34.66	18,521.00
(23) Pulleys and conveyors	512,100	.17	28.79	14,745.00
(24) Picker sticks and bobbins	437,000	.15	26.66	11,650.00
(25) Printing material	391,000	.13	23.17	9,061.00
(26) Frames and molding, picture	281,845	.10	37.13	10,464.00
(27) Carpet sweepers (probably for handles)	236,394	.08	16.10	3,816.00
(28) Equipment, playground	180,000	.06	31.19	5,615.00
(29) Rollers, shade and map	161,150	.06	22.81	3,676.00
(30) Elevators	145,700	.05	68.68	10,007.00
(31) Instruments, professional and scientific (including litters)	123,600	.04	61.93	7,654.00
(32) Laundry appliances	111,500	.04	23.68	2,640.00
(33) Machinery and apparatus, electric	87,000	.03	49.20	4,280.00
(34) Mine equipment	43,425	.01	22.01	956.00
(35) Brushes	36,400	.01	41.54	1,512.00
(36) Patterns and flasks	35,000	.01	37.86	1,325.00
(37) Whips, canes, and umbrella sticks	30,000	.01	60.00	1,800.00
(38) Dowels	29,000	.01	25.34	735.00
(39) Caskets and coffins	20,000	.01	54.00	1,080.00
(40) Butchers' blocks and skewers	20,000	.01	60.00	1,200.00
(41) Aeroplanes	12,000	(1)	64.67	776.00
(42) Weighing apparatus	5,900	(1)	39.66	234.00
(43) Gates and fencing	700	(1)	18.57	13.00
Total	295,461,482	100.00	32.24	9,525,329.42

[1] Less than one one-hundredth of 1 per cent.

HANDLES.

Certain classes of handles are almost exclusively made out of ash, such as "D" handles for spades and shovels of all kinds and long handles for forks, hoes, rakes, and long shovels. Ash is also used somewhat for handles for cant hooks and grubbing hoes. Odds and ends are often used for small tool, whip, broom, ax and pickax, carpet, and vacuum sweeper handles. It is practically the only wood used for snaths for scythes and cradles. The qualities which make ash especially suitable for handles are straightness of grain, a high degree of stiffness and strength perpendicular to the grain, suitable weight and hardness, and capacity to wear smooth in use. Rapid-growing second-growth white and green ash, which yield the strongest and stiffest wood, are the best and the most often used.

Old-growth ash is usually considered too fine-grained and brittle. Sixty per cent of the timber for handles comes from Ohio, Indiana, and Arkansas. (See Pls. I and X.)

Handle stock usually is sawed out directly from the log in order to have the grain straight, and as a rule can not be made from lumber sawed for general purposes. The price of ash stumpage for handles is from $5 to $35 per 1,000 board feet, according to its location and quality, the average being about $15. The cost of the raw material, delivered at the factory, is from $25 to $50 (the average is $30) per 1,000 board feet in logs and in sawed squares.

In Maine some D-handle factories purchase ash in the form of rived billets or blanks,[1] for which they pay an average of 85 cents per dozen delivered at the railroad. It is possible for a workman to split out about 40 dozen handles per 1,000 board feet of bolts, at a cost of about $10 for cutting and riving, and worth about $34 delivered at the railroad. The hauling and freight charges on blanks are, of course, much less than on logs or bolts, and often make it profitable to get them out in this form where it would not pay in bolt form on account of the distance from the market.

DAIRY SUPPLIES.

Practically all of the ash used for dairy supplies goes into butter-tub staves and heading, and covers and hoops for butter churns; a small amount is used for ladles, packers, and butterworkers. Butter tubs are almost always made of ash. It is especially suitable for this purpose because there is nothing in the wood to give butter a disagreeable flavor and because it is very readily worked up into the forms of material used in making the tubs. Slightly more than 50 per cent of the ash manufactured into dairy supplies is used in Illinois, and 28½ per cent in Iowa. The cost of the raw material (manufactured staves, heading, and hoops) amounts to from $10 to $33 per 1,000 board feet delivered at the factory. The average is about $25.

Most of the ash butter-tub material is Mississippi Valley green ash. The hoops, however, are made almost entirely from the black ash of the Lake States. There is practically no difference in the relative desirability of the different species of ash for butter tubs.

The ash butter-tub stave and heading industry utilizes chiefly short lengths cut from small, crooked trees, but only clear material. Knotty stuff can be used for No. 2 staves and heading in lime and other kinds of slack barrels. Logs too crooked to make lumber or long handles can be readily cut up into short bolts 32 inches long and used for making staves and heading. Ash staves are manufactured

[1] Information supplied by G. N. Lamb of the Forest Service.

directly from the log, and ash heading very largely so. Out of 1,000 feet Doyle scale of small logs, often as many as 5,000 staves can be sawed; while out of 1,000 board feet of sawed lumber only about 2,500 staves can be produced, which indicates the advantage of direct conversion of logs into staves. However, some mills in Texas which are remote from the general hardwood market find it profitable to work up their No. 3 common ash lumber into butter-tub heading.

Ash bolts delivered at the factory manufacturing butter-tub staves and heading are worth from $5 to $10 per cord of 128 cubic feet, and stumpage is worth from $2 to $6 per cord (or from $4 to $12 per 1,000 board feet log scale).

VEHICLES.

Ash is extensively used in all kinds of vehicle construction. A number of qualities of the wood make it suitable for a great variety of vehicle parts; it is very strong for its weight; it is tough and elastic and bends well (especially second-growth ash); it retains its shape; is not likely to warp (especially old growth); and wears well. For parts, such as poles, tongues, shafts, trees, axles, braces, and bottom boards, which require strength and toughness, second-growth white or green ash is used, largely as a substitute for hickory. For parts requiring bending qualities and strength, such as felloes and bows for vehicle tops, second-growth white and green ash is also used. For vehicle bodies of all kinds and for panels old growth of all species of ash is preferred, because it can be obtained in larger sizes and greater widths, is not so likely to warp, and holds glue better than second growth. White and green ash are the leading species of ash used in the vehicle industry; only a small per cent of black ash is used because of its inferior strength and toughness.

About 20 per cent of all the ash used in vehicle construction is for automobiles, and about equal amounts of the remainder are used for wagons and heavy vehicles and for buggies and light vehicles.

The average price of ash lumber used in this industry is high because a large proportion of upper grades is required; and the total cost, delivered at the factory, is greater than in the dairy supply industry. A considerable amount of ash is sawed into special sizes for vehicle stock from small logs. The average price for white ash delivered at the factory ranges from $18 in Tennessee to $142 in Oregon. The general average for the whole country is from $40 to $45. Michigan, Indiana, Ohio, Pennsylvania, and New York are the leading States in the use of ash for vehicles. Ash stumpage suitable for vehicle stock commands from $5 to $25, an average of $15 per 1,000 board feet. Fifteen dollars would be too high, however, in the South, because of the great distance from the market and the high cost of transportation.

PLANING MILL PRODUCTS.

For flooring, ceiling, siding, stairs, window and door frames, cabinet work, mantels, and interior fittings of all kinds, including picture frames and molding, ash is desirable because of its handsomeness of grain and figure, its polishing and wearing qualities, its comparative workability, and because it holds its shape well, is not likely to warp, and is strong. Old growth is uniformly superior to second growth for these purposes, because it retains its shape better, and because clear lumber, often of good width, which can best be secured from large, old-growth trees, is usually required, and strength is a secondary consideration.

Ash used in this industry is secured from all three of the important commercial species—white, green, and black. In proportion to its total cut, black ash probably contributes more than white or green. Black ash is used especially for ceiling, siding, flooring, and cabinet work; and most of the curly ash, highly prized for interior work, is from black ash.

The cost of the ash lumber for planing-mill purposes, delivered at the factory, varies from $10 in Arkansas to $70 in California. The average price is about $31. Stumpage prices of ash to be used for planing-mill products are much the same as for ash to be used for rough lumber and range from $3 to $15, with an average of about $9 per thousand.

REFRIGERATORS AND KITCHEN CABINETS.

Ash is much used in the construction of refrigerators and kitchen cabinets on account of the same quality that make it desirable for dairy use; that is, the absence of any odor which can be absorbed by food. It is also desirable because it works well, holds its shape well, is strong and fairly durable, finishes well, and makes a handsome exterior. A little over 50 per cent of the total ash used in this industry is consumed in Michigan alone, and 22 per cent in Wisconsin. Probably black ash is most used; white ash is used to some extent, and green ash but little, because it is too far away from the factories.

The price paid for ash used in this industry ranges from $24 to $46, and averages about $30 per 1,000 board feet.

FURNITURE, CHAIRS, AND CHAIR STOCK.

Ash is a desirable furniture wood because it has a handsome grain, especially old-growth black ash, finishes well, and takes a high polish; also because it is strong, fairly light, easily worked, has excellent bending qualities, and retains its shape well. In amount used it does not rank high among the species that go into this industry, because of its comparative scarcity and the high price it commands for

other purposes. It is used for all kinds of tables and chairs, especially for bent parts, and for desks, filing cabinets, bookcases, racks of all kinds, chamber suits, bureaus, couch frames, stands, piano stools and benches, china closets (inside work), buffets, porch and lawn seats and swings, and parts of reed furniture. It has the quality of being easily racked apart into thin, very elastic strips one-tenth of an inch or less in thickness and an inch or so wide, suitable for splint chair bottoms.

The price paid for ash lumber used in this industry varies from $10 in Alabama to $110 in California, and averages about $27 per 1,000 board feet.

CAR CONSTRUCTION.

Car construction is a very important use for high-priced upper grades of ash lumber, especially timbers of good thickness and width cut from old-growth ash. Ash is sufficiently strong, stiff, tough, and elastic for car frames; it is handsome for interior finish, being susceptible of a high polish, wearing well, and retaining its shape; and its bending qualities make it desirable for bows for bent wood around windows and doors, also for bent panels. The average price for car construction, delivered at the factories, is about $50 per 1,000 board feet. The price of eastern white ash used in car factories in California is $126 per 1,000 board feet. Pennsylvania, Illinois, Missouri, and Ohio are the leading States in the use of ash for car construction. White, green, and black ash are all suitable for this industry.

AGRICULTURAL IMPLEMENTS.

The same qualities which make ash desirable for vehicle construction and for handles make it suitable for agricultural implement parts of all kinds. The States leading in the use of ash for this purpose are Arkansas, Michigan, New York, Indiana, and Pennsylvania. The price paid ranges mostly from $20 to $60 and averages about $40 per 1,000 board feet. In California $116 was paid for ash used in this industry. Second-growth white and green ash are most used, and the proportion of black ash is very small.

BOXES AND CRATES.

Ash lumber and logs of the lower grades and of inferior quality are used to a moderate extent in the construction of boxes, crates, and baskets, for which purposes ash is desirable wherever it can be purchased at a sufficiently low price. It is excellent for boxes or portions of boxes requiring strength, such as the bottoms of piano cases. Where there is considerable low-grade ash, it is used for vegetable and fruit crates, especially black ash at some points in the Lake States and green ash in the South. In basketwork ash is

used for bent-frame parts and for slats or splints to baskets made by racking apart thin strips between the annual rings. Black ash is the chief ash used in basketwork. The Indians of New England taught the white settlers the art of making splint baskets from black ash.

The price of ash used for boxes, crates, and baskets ranges mostly from $10 to $25, and averages about $14 per 1,000 board feet. Michigan, Illinois, Texas, and Wisconsin are the leading States in the use of ash for this industry.

SHIPS AND BOATS.

The chief use of ash in the ship and boat industry is for oars, into which goes over 80 per cent of the total. Practically all long oars and sculls (14 feet and over in length) and a very large proportion of short oars and paddles are made of ash. The United States supplies the world with ash boat oars, both in the rough and finished. A combination of qualities makes ash superior to other woods for oars—it is elastic to a high degree, and is tough, strong, and comparatively light; it is straight grained and easily worked, takes a good polish, wears smooth, and lasts fairly well. Ash for oars is mostly green ash from Tennessee, Mississippi, Louisiana, and Arkansas. Ash logs for oars cost, delivered at the factory, from $20 to $40 per 1,000 board feet, and about $30 on the average. They must be straight and free from defects, 8 feet and up in length, and 12 inches and up in diameter at the top end. White ash was originally the chief supply for oars until it became too scarce. Black ash is not suitable, as it will water-soak, becoming soft and spongy.

Ash is used to a small extent in general ship and boat construction for frames for small craft, tillers for canal boats, interior finish, benches, ribs, and keels.

SPORTING AND ATHLETIC GOODS.

The qualities of ash that make it an unusually desirable wood for baseball bats, tennis racquets, snowshoes, skis, polo sticks, hockey sticks, gymnasium goods, billiard tables, bowling alleys, fishing rods, and playground equipment are its high elasticity, toughness, strength, and comparative lightness. For baseball bats ash is used almost to the exclusion of other woods; it supplies a very large proportion of tennis-racquet frames, polo sticks, and hockey sticks. Ash used in this industry is mostly tough second-growth white ash, ranging usually in price from $30 to $50 per 1,000 board feet for lumber delivered at the factory. The stock is often specially sawed with reference to the particular use to which it is to be put, as for baseball bats. In New England, in this industry, ash is often

bought in log or bolt form, and $40 to $50 per 1,000 paid for good clear stuff delivered to the factory.

FIXTURES.

Ash is a desirable wood for fixtures because of its handsome grain and finishing qualities and because it is durable, wears smooth, and is tough and strong. It is used especially for store, office, bank, school, and church fixtures, including railings, counter tops, show cases, cabinets, partitions, seats, and pews. The price of ash for fixtures averages about $37 per 1,000 board feet, considerable lumber of upper grades being used. Ohio, Illinois, Michigan, and Iowa lead in the use of ash for fixtures. All three of the important commercial species are used.

MUSICAL INSTRUMENTS.

Ash is used to a moderate extent in the construction of various kinds of musical instruments, including pianos, organs, piano players, banjos, harps, and tambourines. It is used for piano frames, backs, keys, inside work, and molding. It is a substantial wood for musical instruments, as it holds its place well, finishes and wears well, is easily worked, and is tough and strong. The better grades of ash lumber are used almost exclusively, and the price paid at the factory averages about $55. Illinois, New York, Maryland, and Missouri are the leading States using ash in musical instruments. White, green, and black ash are all used in this industry.

WOODENWARE AND NOVELTIES.

Ash woodenware and novelties include chiefly ladder rounds, step-ladders, buckets, pails, tubs, staffs, small flagpoles, butchers' blocks, and carving boards. The qualities which make ash desirable in these articles are, in general, its straightness of grain, strength, workableness, and wearing ability. Lumber of the lower grades is used most, because it is largely sawed up into short pieces, so that defects can be readily eliminated where desired. The average price at the factory for the ash lumber used is about $29 per 1,000 board feet. The price of material used for buckets ranges low, while that for ladders is high.

SADDLES AND HARNESS.

Hames are made from over 80 per cent of the ash used in the saddle and harness business. Ash is especially desirable for hames because it is strong and tough yet comparatively light. It is also used for saddletrees and stirrups. Second-growth white ash is the most desirable and is chiefly used. The price paid averages $35 per 1,000 board feet, delivered at the factories. Eighty per cent of the total is used in New Hampshire and New York.

MACHINE CONSTRUCTION.

Ash is suitable for frames in machine construction and machine parts because it is a strong, tough, dependable wood, and is straight-grained and easily worked. Considerable ash of upper grades is used. The price paid averages about $45 per 1,000 board feet, delivered at the factory. White ash is used most. Two-thirds of the total amount of ash in this industry is used in Illinois, and a quarter of it in New York and Wisconsin.

PUMPS.

The chief use for ash in pumps is for sucker rods, for which it is adaptable because its straight grain and workableness make possible the cutting out of strong rods of small diameters. Considerable black ash is used. Tennessee uses over half of the total. The price paid is low—from $14 to $25 per 1,000 board feet—because factories are located near the source of supply and buy material in the log.

TOYS.

Ash is of considerable importance in the toy-making industry in New York, Pennsylvania, and Wisconsin. The average price paid for the ash lumber used is about $33. Old-growth ash, especially black ash, will usually best fulfill the requirements, as it holds glue better than second-growth and is not so likely to warp.

TANKS, SILOS, AND WINDMILL PARTS.

White ash is used to a minor extent for tanks, silos, and windwill parts in New York, Illinois, and Wisconsin. In New York it is low-grade material for tanks and silos; in Illinois and Wisconsin it is high-priced ash for windmill parts. The average price for ash in this industry is about $33.

PLUMBERS' WOODWORK.

Ash is used for plumbers' woodwork in Vermont, Pennsylvania, Ohio, and Illinois. Drainboards, connected with sinks, are often made of ash, as it is exceedingly well adapted for this use. The average price paid for lumber used in this industry is about $25 per 1,000 board feet.

TRUNKS.

Ash is a desirable wood for trunks, although only a small amount of it is used in proportion to some other species. The greater part of a trunk is usually made out of some lighter wood, such as basswood. Ash is suitable for bottoms, corners, tops, and slats. The price paid averages about $35 per 1,000 board feet.

PULLEYS AND CONVEYORS.

Only a small amount of ash is required in the manufacture of pulleys and conveyors. The average price paid is low, about $29 per 1,000 board feet, as short lengths can be used. Connecticut and New York are the leading States in amount used. In this industry ash is an important wood for tackle-block material, and to a lesser extent for belt pulleys and conveyors.

PICKER STICKS AND BOBBINS.

Ash lumber for picker sticks costs about $27 per 1,000 board feet. Some ash is used for bobbins.

PRINTING MATERIAL.

Ash for printing material is used chiefly in Michigan. The average price paid for the lumber is low, about $23 per 1,000 board feet, because it is near the source of supply and because lumber of the lower grades can be used.

PICTURE FRAMES AND MOLDING.

Ash is a wood of less importance in the manufacture of picture frames and molding. It is used chiefly in Illinois, Michigan, Wisconsin, and Maryland. Old-growth black ash is probably preferable for this use. The average price paid is rather high—about $37 per 1,000 board feet, delivered at the factory.

PLAYGROUND EQUIPMENT.

Ash is an excellent wood for use in playground equipment because of its ability to wear smooth and because of its comparative strength and lightness. The average price paid for ash lumber for this use is about $31 per 1,000 board feet.

SHADE AND MAP ROLLERS.

Ash is of some importance in the manufacture of shade and map rollers, and especially for curtain poles in Tennessee. The average price paid for lumber, about $23 per 1,000 board feet, is low because the factories are near the source of supply.

ELEVATORS.

Ash is of considerable importance in elevator making in Pennsylvania. It is used chiefly for guide strips because of its ability to wear smooth. The average price paid is high—about $69 per 1,000 board feet.

PROFESSIONAL AND SCIENTIFIC INSTRUMENTS.

Ash is used for tools and instruments, especially for carpenter's tools. More is used for this purpose in New Jersey than elsewhere. The average price paid is high—about $62 per 1,000 board feet.

AEROPLANES.[1]

Ash is the second most important wood used in aeroplanes. The great bulk of the wood used is spruce from the Pacific coast and West Virginia. The essential qualities needed in wood for aeroplanes are straightness of grain, strength, absolute freedom from hidden defects, lightness (in comparison with strength), and ability to stand extreme stress. Ash is used in framework, main outriggers on which the canvas is stretched, uprights bearing the engine or forming the engine bed, skids (on the upright, curving ends of which the alighting wheels are fixed), rudders, and propeller blades. For framework, outriggers, and uprights straightness of grain and strength are the essential qualities needed, which usually can be best supplied by rapid-growing, comparatively young growth, from 75 to 150 years old. For propeller blades, for which ash is very largely used, the quality desired, in addition to strength in comparison with weight, is ability of the wood to hold its shape, which is best supplied by old-growth ash. Propeller blades are made from laminated blocks consisting of several layers of different kinds of wood glued and nailed together. An excellent combination is said to be a middle layer of ash with spruce on either side, then layers of mahogany on the spruce, and thin layers of ash on the outside.[2] Engine blocks and frame ribs are also often laminated in construction, spruce and ash being combined to divide the stress.

The average price for ash lumber used for aeroplanes is very high, about $65 per 1,000 board feet, and there is much waste in utilization. A Chicago firm in 1912 paid $180 for 600 feet of specially sawed ash, or at the rate of $300 per 1,000 feet, which is probably a record price for ash lumber.

EXPORT.

From five to seven million feet of ash logs are exported annually to Europe, chiefly green ash from the South Atlantic and Gulf States. Export dealers pay from $30 to $40 per 1,000 board feet

[1] Information supplied by J. T. Harris, Office of Industrial Investigations, Forest Service.

[2] Great trouble has been experienced from the splitting and checking of wooden aeroplane propellers, when made from laminated blocks either of a single material or of different woods. This can best be prevented by use of thoroughly air-seasoned woods, and by keeping propellers out of doors at all times, or by giving them a coating of paraffin to prevent the entrance of moisture.

(Doyle scale) for rafts of ash logs delivered for loading on trans-Atlantic steamers, and make a good margin of profit on the operation. The logs are mostly 12 inches and up in top diameter, and 12 feet and up in length, although some smaller logs down to 6 inches in diameter are also exported. The exporters figure that the smaller amount of timber shown by Doyle's rule in proportion to what can be cut out from the smaller sized logs warrants paying the same price.

Several million feet of ash lumber, in deal or plank form, are also exported yearly to Europe and South America.

During the last part of the eighteenth century American ash began to supplant European ash (from the Baltic region) in English shipbuilding, because of its superior qualities, and large quantities were exported to England for this purpose for nearly a century. It is used for rafters, oars, capstans, bars, blocks, levers, handspikes, pins, etc.

FUEL.

The chief minor use of ash is for fuel, for which green ash is especially used in parts of the Southern States, such as localities along the lower Mississippi River where there is not much pine. It is very easily split, comparatively light, and makes a quick, hot fire. A fairly large quantity of ash finds its way to fuel yards, and charcoal burners also use much of it. Ash has a fuel value of about 90 per cent of that of oak.

FENCING AND OTHER FARM USES.

Ash is used to a minor extent for fence posts and rails in places where better suited timber is not available, such as the Prairie and Plains States. Black and blue ash are the most durable ash woods for posts, but all species make strong, light rails. Ash is good for rough and ready wagon poles cut by the farmer. The possibilities in these and other general farm uses can be greatly extended by creosoting.

MISCELLANEOUS.

Black ash is used for mine timbers. It has also been used successfully for chemical pulp, along with birch, beech, and maple, by one large concern in Elk County, Pa. White, green, black, and Oregon ash bark is used to a limited extent in the drug business—after the removal of the outside corky layer. From three to five cents per pound is paid to collectors of this material. It is not, however, an official drug and is of small commercial importance. Ash wood is distilled to a very limited extent along with birch, beech, and maple for the production of wood alcohol, acetate, and charcoal. Sticks of

black ash are used occasionally in mixture with other hardwoods for chemical pulp. Ash saplings, an inch or so in diameter, are used in New England for barrel hoops in the absence of hickory. They are split into two to four pieces, and the hoops made from 4½ to 10 feet long. The hoops bring $4.50 to $12 per 1,000, depending on the size, and cost $2 to $4 per 1,000 to produce.

LUMBER AND STUMPAGE VALUES.

ASH LUMBER PRICES.

Present wholesale prices of different grades of ash lumber in the principal centers of its distribution are given in Table 13. These prices are for ash in car lots as sold to the retail and factory trades. They are based on lumber properly manufactured and graded under the grading rules of the National Hardwood Lumber Association and, to a less extent, those of the Hardwood Manufacturer's Association. These two rules are quite similar in wording, but the former requires inspection to be made on the poorer side of the piece, while the latter requires both sides to be considered in determining the grade. Also, the latter has a grade of No. 4 common which the former does not have. Inspection on one side is more satisfactory from the jobber's standpoint, while inspection on both sides is preferable to the manufacturers.

The standard lengths for ash lumber are from 4 to 16 feet, and the standard thicknesses are usually 1, 1¼, 1½, 2, 2½, 3, and 4 inches when dry.

Bright sap is no defect in the "first and seconds" grade in ash, while in plain sawed oak it is only admitted as no defect when less than one-half the width of the board in the aggregate on the one side, and in quarter-sawed oak when not over 1 inch in pieces 8 inches and over wide. This makes the grading of ash less rigid than that of oak.

TABLE 13.—*Wholesale prices*[1] *of ash lumber in important centers of lumber distribution and utilization.*

[Prices are per 1,000 board feet.]

	Firsts and seconds, 5 inches and up wide.			No. 1 Common, 4 inches and up wide.			No. 2 Common, 3 inches and up wide.			No. 3 Common, 3 inches and up wide.		
	1 inch thick.	2 inches thick.	4 inches thick.	1 inch thick.	2 inches thick.	4 inches thick.	1 inch thick.	2 inches thick.	4 inches thick.	1 inch thick.	2 inches thick.	4 inches thick.
Boston	$53.50	$65.00	$79.50	$38.50	$44.00	$57.00	$29.50	$30.50	$35.50	$21.50	$22.50	$24.50
New York	53.00	64.50	79.00	38.00	43.50	56.50	29.00	30.00	35.00	21.00	22.00	24.00
Buffalo	49.50	61.00	75.50	36.50	40.00	53.00	25.50	26.50	31.50	17.50	18.50	20.50
Philadelphia, Baltimore, and Washington	52.00	63.50	78.00	37.00	42.50	55.50	28.00	29.00	34.00	17.00	17.00	20.00
Pittsburgh	49.50	61.00	75.50	34.50	40.00	53.00	25.50	28.50	31.50	17.50	18.50	20.50
Richmond and Norfolk	49.00	60.00	75.00	33.00	38.50	51.50	25.00	26.00	31.00	17.00	18.00	20.00
Knoxville	42.00	53.50	67.00	28.00	32.50	45.00	18.00	19.00	23.50	10.00	11.00	13.00
Nashville	42.00	53.50	68.00	27.00	32.50	45.50	18.00	19.00	24.00	10.00	11.00	13.00
Louisville	45.00	56.00	75.00	30.00	35.00	46.00	18.00	23.00	28.00	12.00	13.00	16.00
Cincinnati	46.00	57.50	72.00	31.50	36.50	51.50	22.00	23.00	28.00	14.00	15.00	17.00
Evansville	45.50	57.00	71.50	30.50	36.00	49.00	21.50	22.50	27.50	13.50	14.50	16.50
Chicago and Indianapolis	47.50	59.00	73.50	32.50	38.00	49.00	23.50	24.50	29.50	15.50	16.50	18.50
Detroit, Cleveland, and Grand Rapids	49.00	60.50	75.00	33.00	39.50	52.00	25.00	26.00	31.00	17.00	18.00	20.00
Wausau, Wis	43.50	54.00	69.50	28.50	34.00	47.00	19.50	19.50	26.50	11.50	12.50	14.50
St. Paul and Minneapolis	50.00	61.50	76.00	35.00	40.50	53.50	25.00	27.00	32.00	17.00	19.00	21.00
St. Louis	45.00	56.50	71.00	30.00	35.50	46.50	21.00	22.00	29.50	13.00	14.00	16.00
Kansas City	46.50	58.00	72.50	31.50	37.00	50.00	22.50	23.50	28.50	14.50	15.50	17.50
Denver	45.00	66.50	81.00	40.00	45.50	60.50	31.00	32.00	37.00	.....	.....	.....
Los Angeles, San Francisco, and Seattle	63.50	75.00	89.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cairo and Thebes	44.00	55.50	70.00	29.00	33.50	48.50	20.00	21.00	26.00	12.00	13.00	15.00
Memphis	41.00	52.50	67.00	26.00	31.50	42.50	17.00	18.00	23.00	9.00	10.00	12.00
New Orleans	44.00	55.50	70.00	29.00	34.50	47.50	20.00	21.00	26.00	12.00	13.50	15.00

[1] Figures taken from the market report of Sept. 15, 1916, of the Lumberman's Bureau, Washington, D. C. These prices claim to represent actual selling prices in the principal markets of lumber in car lots to the retail and factory trade.

The f. o. b. value of properly manufactured and graded ash lumber at any particular mill is the difference between its wholesale value at the nearest city in the list given in the table and the wholesaler's profit and expenses—the latter chiefly freight. In some cases the f. o. b. mill value should be more, as where the timbers can be marketed locally or at a point with a lower freight rate than to any given in the list or where the wholesaler's profit can be eliminated.

Small second-growth ash logs which would not cut a high per cent of upper grades are often worth more f. o. b. mill for shipment to some factory for special uses, such as for handles of all kinds, than if manufactured into graded lumber. In Ohio such logs to be used for handles are worth from $30 to $40 per 1,000 feet log scale delivered at factory, which admits of a $15 to $35 value per 1,000 board feet for logs f. o. b. local station for material too small in diameter to cut out more than a very small per cent of upper grades. In Arkansas from $15 to $20, and in Virginia $40, is paid for ash logs for handles, delivered at the factories.

Ash logs for export command an equally high price, which offers an important prospective market for ash grown under forest management where there is cheap transportation to the coast.

Table 14 gives the average wholesale price f. o. b. mill for ash lumber in various States from 1909 to 1916.[1]

The prices quoted are for one inch (4/4) thick lumber of the firsts and seconds, No. 1 common, and No. 2 common grades, and mill-run values or average prices for all grades produced.

TABLE 14.—*Average wholesale prices of ash lumber (per 1,000 board feet) in various States, based on actual sales made f. o. b. mill for the years 1909–1916.*

State.	1909	1910	1911	1912	1913	1914	1915	1916
Alabama:								
Firsts and seconds, 4/4	$35.50	$33.50	$35.59	$35.29	$42.44	$44.46	$44.50	.....
No. 1 common, 4/4	22.17	22.33	22.67	21.04	25.50	25.96	24.50	.....
No. 2 common, 4/4	11.09	14.32	13.25	10.84	15.19	15.08	14.83	.....
Mill run	.....	.....	.....	.....	26.12	23.50	22.25	.....
Arkansas:								
Firsts and seconds, 4/4	36.62	36.90	35.94	36.64	41.49	41.08	39.89	$40.00
No. 1 common, 4/4	21.31	20.43	20.12	21.42	25.00	23.46	26.04	26.35
No. 2 common, 4/4	10.91	11.15	10.93	11.25	13.67	13.62	11.74	.....
Mill run	21.10	22.20	20.60	20.33	.....	22.00	27.98	.....
Connecticut:								
Firsts and seconds, 4/4	27.00	37.50	.....	.....	.....	.....	.....	.....
No. 1 common, 4/4	30.00	.....	.....	24.12	.....	.....	.....	.....
No. 2 common, 4/4	21.00	.....	.....	.....	.....	.....	.....	.....
Mill run	20.62	21.49	21.36	17.82	.....	.....	.....	.....
Indiana:								
Firsts and seconds, 4/4	38.78	40.33	40.10	39.18	.....	.....	.....	.....
No. 1 common, 4/4	25.39	25.19	25.24	25.91	.....	.....	.....	.....
No. 2 common, 4/4	15.94	18.20	18.78	16.40	.....	.....	.....	.....
Mill run	23.30	25.89	26.46	22.15	.....	.....	.....	.....
Illinois:								
Firsts and seconds, 4/4	37.13	37.73	41.25	.....	.....	.....	.....	.....
No. 1 common, 4/4	22.62	24.93	25.00	24.67	.....	.....	.....	.....
No. 2 common, 4/4	12.81	.....	17.38	.....	.....	.....	.....	.....
Mill run	23.89	.....	.....	.....	.....	.....	.....	.....
Kentucky:								
Firsts and seconds, 4/4	38.01	37.82	38.05	39.20	46.08	44.25	45.17	46.00
No. 1 common, 4/4	23.41	24.30	24.17	24.47	29.80	27.00	28.17	26.00
No. 2 common, 4/4	13.52	16.00	16.52	14.79	17.36	16.00	16.67	16.00
Mill run	22.44	21.65	20.89	19.75	29.41	26.00	.....	28.00
Louisiana:								
Firsts and seconds, 4/4	35.42	35.50	35.15	36.30	32.67	37.00	37.12	38.50
No. 1 common, 4/4	20.84	21.12	19.32	19.74	18.67	21.62	21.88	23.00
No. 2 common, 4/4	10.84	10.47	10.27	10.87	9.33	11.88	11.75	13.00
Mill run	.....	20.57	.....	18.67	22.17	25.50	24.18	.....
Massachusetts:								
Firsts and seconds, 4/4	30.00	.....	.....	.....	.....	.....	.....	.....
No. 1 common, 4/4	.....	.....	.....	24.20	.....	.....	.....	.....
No. 2 common, 4/4	.....	.....	.....	.....	.....	.....	.....	.....
Mill run	21.63	21.45	21.76	18.67	.....	.....	.....	.....
Missouri:								
Firsts and seconds, 4/4	36.23	38.48	37.22	.....	43.50	38.38	40.38	39.75
No. 1 common, 4/4	22.28	23.19	22.00	.....	29.00	24.00	24.46	23.75
No. 2 common, 4/4	12.31	14.10	15.00	12.67	17.50	13.88	15.04	13.75
Mill run	25.79	20.25	20.84	.....	.....	20.25	22.03	20.00
Michigan:								
Firsts and seconds, 4/4	39.25	38.14	39.66	39.22	42.00	.....	.....	.....
No. 1 common, 4/4	28.26	27.58	26.71	26.18	32.00	.....	.....	.....
No. 2 common, 4/4	17.04	25.53	25.42	17.53	30.44	31.52	.....	.....
Mill run	22.63	22.18	21.87	20.68	22.25	21.34	.....	.....
Mississippi:								
Firsts and seconds, 4/4	35.98	36.28	35.26	34.88	37.44	40.25	40.79	38.33
No. 1 common, 4/4	21.44	22.70	20.58	22.33	22.33	24.62	23.33	23.00
No. 2 common, 4/4	10.97	10.80	10.56	10.96	10.67	14.00	13.75	13.00
Mill run	29.23	20.50	24.00	.....	32.11	.....	25.50	30.00

[1] Based on reports of actual sales, received by the Forest Service from a number of the largest manufacturers in the different States.

TABLE 14.—*Average wholesale prices of ash lumber (per 1,000 board feet) in various States, based on actual sales made f. o. b. mill for the years 1909–1916*—Continued.

State.	1909	1910	1911	1912	1913	1914	1915	1916
North Carolina:								
Firsts and seconds, 4/4	$38.19	$39.21	$38.29	$38.84	$38.00	$26.67	$38.62	$38.00
No. 1 common, 4/4	25.67	26.71	25.35	24.84	24.00	25.33	25.25	26.00
No. 2 common, 4/4	12.84	12.33	14.94	12.50	11.00	14.00	13.75	13.00
Mill run	17.00	15.85	15.50	.....	.....	24.00	26.67	27.00
New York:								
Firsts and seconds, 4/4	39.74	44.27	42.96	39.98	.....	.....	.....	.....
No. 1 common, 4/4	28.76	30.50	28.33	26.96	.....	.....	.....	.....
No. 2 common, 4/4	16.02	20.32	22.44	18.16	.....	.....	.....	.....
Mill run	23.96	22.76	23.77	20.88	.....	.....	.....	.....
New Hampshire: Mill run	22.95	22.42	20.50	19.78	.....	.....	.....	.....
Ohio:								
Firsts and seconds, 4/4	41.65	43.18	42.02	38.64	47.00	55.00	49.62	50.00
No. 1 common, 4/4	28.01	28.92	28.76	28.03	28.50	34.00	30.00	30.00
No. 2 common, 4/4	17.07	19.01	18.55	17.28	17.50	23.00	21.00	20.00
Mill run	25.53	25.31	25.44	.....	19.50	27.00	30.40	26.00
Pennsylvania:								
Firsts and seconds, 4/4	39.17	41.11	36.94	40.00	.....	.....	.....	.....
No. 1 common, 4/4	29.11	28.01	25.75	26.50	.....	.....	.....	.....
No. 2 common, 4/4	17.44	23.07	20.50	.....	.....	.....	.....	.....
Mill run	25.40	25.95	25.09	21.85	.....	.....	.....	.....
South Carolina:								
Firsts and seconds, 4/4	.....	38.25	.....	.....	.....	.....	.....	.....
No. 1 common, 4/4	.....	19.00	.....	.....	.....	.....	.....	.....
Texas:								
Firsts and seconds 4/4	.....	37.97	39.40	.....	.....	.....	.....	.....
No. 1 common, 4/4	.....	22.15	22.40	.....	.....	.....	.....	.....
No. 2 common, 4/4	.....	10.91	12.50	.....	.....	.....	.....	.....
Mill run	.....	.....	.....	.....	.....	.....	.....	.....
Tennessee:								
Firsts and seconds, 4/4	39.88	37.39	38.04	36.51	45.68	41.99	41.42	42.83
No. 1 common, 4/4	24.79	23.41	24.00	22.86	28.82	26.41	25.60	26.33
No. 2 common, 4/4	13.54	14.50	13.16	12.36	17.57	16.18	15.98	16.00
Mill run	23.63	20.74	21.96	20.50	.....	.....	.....	30.00
Virginia:								
Firsts and seconds, 4/4	37.97	37.54	36.88	37.09	.....	.....	.....	.....
No. 1 common, 4/4	25.51	25.22	23.60	25.33	.....	.....	.....	.....
No. 2 common, 4/4	13.20	17.01	13.23	12.11	.....	.....	.....	.....
Mill run	26.50	19.00	.....	.....	.....	.....	.....	.....
Vermont:								
Firsts and seconds, 4/4	25.20	29.00	.....	.....	.....	.....	.....	.....
No. 1 common, 4/4	24.25	23.50	.....	26.00	.....	.....	.....	.....
No. 2 common, 4/4	19.33	17.33	17.00	.....	.....	.....	.....	.....
Mill run	20.51	18.09	20.26	20.03	.....	.....	.....	.....
West Virginia:								
Firsts and seconds, 4/4	41.03	42.40	42.52	40.47	46.64	46.62	43.88	43.00
No. 1 common, 4/4	28.65	27.84	28.17	28.49	30.86	29.63	26.88	27.00
No. 2 common, 4/4	14.73	18.44	20.71	14.89	18.72	18.88	16.88	17.00
Mill run	21.78	22.79	23.56	18.00	21.50	.....	.....	.....
Wisconsin:								
Firsts and seconds, 4/4	37.27	36.19	36.66	37.54	43.40	47.67	.....	.....
No. 1 common, 4/4	25.00	24.79	23.44	23.94	30.62	33.75	.....	.....
No. 2 common, 4/4	13.78	23.17	22.08	14.42	28.72	31.10	.....	.....
Mill run	21.02	19.73	18.74	18.28	22.73	15.00		

Table 15 gives the average wholesale prices for white and brown ash lumber in various markets for 1908 to 1912.[1] The prices quoted are for 1-inch (4/4) thick lumber only, including firsts and seconds and No. 1 common white ash, and firsts and seconds, No. 1 common, and No. 2 common brown ash.

[1] Based on reports of actual sales, received by the Forest Service from many of the the largest wholesalers in each of the markets quoted.

TABLE 15.—*Average wholesale prices of ash lumber (per 1,000 board feet) in various markets, based on actual sales made f. o. b. each market.*

Market.	1908	1909	1910	1911	1912
Boston:					
White ash—					
Firsts and seconds, 4/4	$53.32	$51.67	$52.83	$52.17	$52.42
No. 1 common, 4/4	40.75	36.17	36.08	35.50	35.25
Brown ash—					
Firsts and seconds, 4/4	54.67	52.46	56.88	54.81	54.92
No. 1 common, 4/4	.....	41.17	45.00	35.25	.....
New York:					
White ash—					
Firsts and seconds, 4/4	50.29	50.00	50.00	50.94	51.67
No. 1 common, 4/4	35.54	35.38	32.50	33.50	33.08
Brown ash—					
Firsts and seconds, 4/4	50.67	50.00	55.00	53.25	.....
No. 1 common, 4/4	37.00	35.58	37.67	37.75	.....
No. 2 common, 4/4	.....	22.50	25.00	.....	.....
Philadelphia:					
White ash—					
Firsts and seconds, 4/4	50.96	49.52	52.50	49.25	49.50
No. 1 common, 4/4	33.00	34.46	32.00	32.75	33.12
Norfolk:					
White ash—					
Firsts and seconds, 4/4	.....	45.50	.....	.....	.....
No. 1 common, 4/4	.....	28.50	.....	.....	.....
Buffalo:					
White ash—					
Firsts and seconds, 4/4	52.14	50.29	51.44	51.06	51.25
No. 1 common, 4/4	33.58	32.86	32.75	32.50	31.67
Brown ash—					
Firsts and seconds, 4/4	53.17	51.63	53.06	51.83	52.00
No. 1 common, 4/4	33.67	33.33	33.38	32.75	31.67
No. 2 common, 4/4	.....	39.00	21.17	21.63	21.33
Pittsburgh:					
White ash—					
Firsts and seconds, 4/4	48.25	50.25	51.31	49.42	.....
No. 1 common, 4/4	36.00	35.25	33.75	33.75	.....
Cincinnati:					
White ash—					
Firsts and seconds, 4/4	42.67	43.58	44.56	43.44	45.17
No. 1 common, 4/4	29.97	29.08	28.81	27.25	28.92
Chicago:					
White ash—					
Firsts and seconds, 4/4	46.14	45.41	44.38	46.00	45.33
No. 1 common, 4/4	29.83	29.02	29.17	29.50	28.67
Brown ash—					
Firsts and seconds, 4/4	.....	39.75	37.25	.....	.....
No. 1 common, 4/4	.....	29.50	26.38	.....	.....
No. 2 common, 4/4	.....	16.00	.....	.....	.....
St. Louis:					
White ash—					
Firsts and seconds, 4/4	39.82	40.34	41.00	41.06	41.42
No. 1 common, 4/4	24.79	23.94	24.13	24.75	25.58
Memphis:					
White ash—					
Firsts and seconds, 4/4	39.68	39.60	39.25	38.31	40.25
No. 1 common, 4/4	23.36	23.41	23.38	23.00	24.00
Minneapolis:					
White ash—					
Firsts and seconds, 4/4	38.88	49.25	49.00	43.63	.....
No. 1 common, 4/4	28.75	32.00	32.17	28.00	.....
Brown ash—					
Firsts and seconds, 4/4	.....	38.24	36.92	36.25	37.08
No. 1 common, 4/4	.....	27.64	26.00	25.00	25.75
No. 2 common, 4/4	.....	16.75	15.42	15.00	15.67
Kansas City:					
White ash—					
Firsts and seconds, 4/4	48.75	45.25	.....	49.75	.....
No. 1 common, 4/4	30.00	26.50	.....	33.25	.....
New Orleans:					
White ash—					
Firsts and seconds, 4/4	.....	.....	35.75	36.25	38.25
No. 1 common, 4/4	.....	.....	19.00	20.81	22.25
Denver:					
White ash—					
Firsts and seconds, 4/4	51.15	49.50	.....	53.25	.....
San Francisco:					
White ash—					
Firsts and seconds, 4/4	107.50	98.28	101.88	94.12	96.75
Los Angeles:					
White ash—					
Firsts and seconds, 4/4	89.75	89.38	81.67	85.00	.....

Table 16 shows delivered wholesale prices of white ash inch boards of different grades in Boston, New York, Philadelphia, and St. Louis from 1896 to 1910, inclusive, from figures published by the Bureau of Corporations, Department of Commerce and Labor, based on actual sales in the different markets. That bureau also obtained prices on brown ash, which in the early years showed a price movement somewhat different from that of white ash, but which in later years was much the same.

TABLE 16.—*Actual prices of white ash delivered in Boston, New York, Philadelphia, and St. Louis, 1896–1910 (for rough, 1 inch thick boards).*

Year.	Firsts and seconds.				No. 1 common.			No. 2 common.	
	Boston.	New York.	Philadelphia.	St. Louis.	New York.	Philadelphia.	St. Louis.	New York.	Philadelphia.
1896	.....	$34.62	.....	.....	.....	.....	.....	.....	.....
1897	$35.75	32.00	.....	.....	$20.50	.....	$14.38	$14.50	.....
1898	37.50	32.50	.....	$25.81	22.67	.....	15.75	14.33	.....
1899	39.18	37.92	.....	34.17	29.00	.....	21.45	18.70	.....
1900	42.20	39.00	$35.00	32.34	28.88	.....	22.00	20.00	.....
1901	42.38	38.70	38.25	30.61	27.90	$25.50	20.38	18.10	$14.50
1902	41.42	40.20	40.00	32.08	28.00	27.54	20.21	19.50	16.50
1903	44.40	42.30	39.89	33.96	31.25	27.47	21.71	21.50	16.33
1904	44.67	45.00	40.25	34.07	30.00	28.08	20.54	22.00	15.33
1905	45.38	46.38	41.20	34.39	30.00	28.28	20.50	22.00	17.04
1906	49.25	48.94	45.81	38.72	33.71	33.14	25.03	21.50	18.16
1907	57.00	54.33	51.07	47.56	39.86	38.85	27.40	.....	20.65
1908	54.17	50.00	44.44	38.00	35.50	32.60	23.67	22.67	19.20
1909	49.00	48.75	45.22	40.31	36.75	32.60	24.17	22.67	17.58
1910	52.00	52.44	46.11	41.92	.....	33.00	22.40	25.00	18.25

COST OF PRODUCTION.

There are a number of factors that cause great variation in the cost of producing ash lumber f. o. b. local stations: Distance of timber from the railroad; character of transportation, by train or by horses, and whether over good or poor roads; cost of labor and horse teams; location of the mill, whether portable and located in the timber, or stationary and located on the railroad; and the character of the timber, whether in heavy stands or situated so as to be easily skidded, or the opposite of these. The range in logging and lumbering costs for ash timber located from 6 to 10[1] miles from the railroad shipping point (or where an average of one trip a day team haul is possible) is given in Table 17 separately for (*a*) portable mill lumbering; (*b*) small stationary mill lumbering with log transportation by horses and mill located on railroad; (*c*) large stationary mill lumbering with log transportation by steam and mill located on railroad. It is apparent from this table that steam logging is the cheapest where there is sufficient timber to be logged to warrant putting in a railroad or train outfit. In reckoning the

[1] This distance taken as being greater than the average and hence conservative; for shorter hauls the cost of production would be cheaper, while for longer hauls it would be increasingly higher.

profitableness of forest management for ash, seldom, if ever, will it be safe to count on using steam logging, as the areas under management will be too small. The greater cost of the stationary over the portable mill logging (where horses are used to haul the logs) is offset considerably by the greater possibilities of profitable disposal of mill-cull lumber and slabs by the former, and by the possibilities of closer utilization and better manufacture, resulting in a greater output and better grades of lumber. Furthermore, very small lots of timber containing from 5,000 to 10,000 feet or less in a place can often be profitably logged to a stationary mill, while a minimum of from 50,000 to 100,000 feet is usually necessary to make it profitable to set up a portable mill. (See Pls. II and III.)

TABLE 17.—*Cost of producing ash lumber f. o. b. shipping point from timber located from 6 to 10 miles distant.*

A. PORTABLE MILL IN THE TIMBER.

[Minimum stand to be cut 100,000 feet.]

	Low.	Average.	High.
Cutting and bucking up [1]	$1.00	$1.50	$2.00
Skidding to mill, average distance one-fourth mile	2.50	4.00	5.50
Sawing and yarding of lumber	3.00	4.00	5.00
Hauling and loading on cars	2.50	4.00	5.50
Depreciation	1.00	1.00	1.00
Total	10.00	14.50	19.00

B. SMALL STATIONARY MILL ON THE RAILROAD WITH HORSE LOG TRANSPORTATION.

[No minimum limit to the amount cut from one particular stand.]

Cutting and bucking up	$0.75	$1.25	$1.75
Skidding, loading, and hauling logs to mill	7.50	10.00	12.50
Sawing	3.00	4.00	5.00
Depreciation	1.00	1.00	1.00
Total	12.25	16.25	20.25

C. LARGE STATIONARY MILL ON THE RAILROAD WITH STEAM LOG TRANSPORTATION.

[Minimum limit of 10 million feet on tract logged.]

Cutting and bucking up	$0.75	$1.25	$1.75
Skidding, average distance one-half mile	2.75	4.50	6.00
Loading and hauling logs to mill by steam	1.50	2.50	3.50
Milling, including sticking and loading	3.00	4.00	5.00
Depreciation	1.00	1.00	1.00
Total	9.00	13.25	17.25

[1] The range in costs is higher here than in B and C because the operations usually are smaller and more expensive.

VALUE OF STANDING TIMBER.

The value of standing ash timber in any particular locality may be figured by subtracting from its local f. o. b. value the cost of production and a reasonable margin for profit on the money invested.

Twenty per cent of the cost of production is here allowed for profit in figuring what future ash stumpage, grown under forest management, will be worth, and on this basis Table 18 is constructed, which gives for different costs of production the value of standing ash timber which, when produced, will sell (mill-run) f. o. b., at the different prices indicated.

Ash stumpage to be used for other purposes than lumber, as for handles, oars, etc., will sometimes be worth more, especially small second-growth trees conveniently located which would not cut out a high per cent of upper grades of lumber because the boards would be too narrow. Stumpage values of ash used in different industries have already been referred to (see pp. 28 to 31).

TABLE 18.—*Stumpage values per 1,000 board feet for different f. o. b. mill values and different costs of lumbering, allowing 20 per cent margin for profit on cost of lumbering.*

F. o. b. mill value.	Cost of lumbering.[1]					
	$10	$12	$14	$16	$18	$20
Per 1,000 board feet.	Stumpage[2] value per 1,000 board feet.					
$20	$8.00	$5.60	$3.20	$0.80	.....	.....
$22	10.00	7.60	5.20	2.80	$0.40	.....
$24	12.00	9.60	7.20	4.80	2.40	.....
$26	14.00	11.60	9.20	6.80	4.40	$2.00
$28	16.00	13.60	11.20	8.80	6.40	4.00
$30	18.00	15.60	13.20	10.80	8.40	6.00
$32	20.00	17.60	15.20	12.80	10.40	8.00
$34	22.00	19.60	17.20	14.80	12.40	10.00
$36	24.00	21.60	19.20	16.80	14.40	12.00
$38	26 00	23.60	21.20	18.80	16.40	14.00
$40	28.00	25.60	23.20	20.80	18.40	16.00

[1] Cost of lumbering, including logging and milling costs and depreciation.
[2] Figured by the formula: S= F−(1+rate of interest) times C, where S=stumpage value, F=f. o. b. mill value, and C=cost of lumbering.

From the standpoint of management the value of second-growth stands is the important thing, and this in turn depends largely on the proportion of grades which any particular stand will cut. Table 19 indicates the proportion of the different grades cut from second-growth white ash under 75 years of age of different diameters from comparatively straight and sound trees, such as would be grown in properly managed second-growth stands. The second half of this table shows mill-run value f. o. b. mill per 1,000 board feet of trees of different diameters, taking the following f. o. b. mill prices for the different grades:

	Firsts and seconds.	No. 1 common.	No. 2 common.	No. 3 common.
High	$60	$35	$25	$15
Average	50	30	20	10
Low	40	25	15	5

TABLE 19.—*Proportion of different grades cut from white ash trees of different diameters, from comparatively straight and sound trees under 75 years old, and value f. o. b. mill of the lumber which could be produced from them.*

Diameter breast high.	Grades of lumber.				F. o. b. mill value per 1,000 board feet.		
	Firsts and seconds.	No. 1 common.	No. 2 common.	No. 3 common.	High.	Average.	Low.
Inches.		*Per cent.*	*Per cent.*	*Per cent.*			
8		53	34	13	$29.00	$24.00	$19.00
10	1	51	41	7	29.75	24.70	19.65
12	7	47	40	6	31.55	26.20	20.85
14	22	42	30	6	35.30	29.20	24.10
16	29	42	22	7	38.65	32.20	25.75
18	35	39	19	7	40.75	33.70	26.95
20	43	36	15	6	42.75	35.90	28.75

Stated in general terms, the mill-run value of second-growth ash from comparatively straight and sound trees of all three commercial species ranges about as follows:

Size of trees in diameter breast high.	Value f. o. b. mill per 1,000 board feet of lumber.		
	Low.	Average.	High.
7–11 inches	$20	$24	$29
12–16 inches	24	29	36
17–21 inches	28	34	40

Taking $14 as an average cost for logging and milling, allowing 20 per cent for profit, and using the average values given above, would give average stumpage values as follows:

Size of trees in diameter breast high.	Average stumpage value per 1,000 board feet.
7–11 inches	$7.20
12–16 inches	12.20
17–21 inches	17.20

Probably a record price for ash stumpage was paid in 1913 in east-central Illinois (near the Indiana line) when $32 per thousand board feet was paid for a quarter million feet of old-growth white ash, while on the same tract $125 per thousand board feet was paid for black walnut, $24.75 for white oak, and $18.05 for hickory.

SUMMARY OF IMPORTANT POINTS.

Ash lumber is an extremely valuable wood for special uses. The supply of standing ash timber is becoming limited, and to maintain enough to meet the demand commercial growing of ash is necessary.

The following are the uses for which standing ash timber containing various kinds of material is most suitable and profitable:

1. Clear, rapid-growing second-growth timber of white, green, blue, and Biltmore ash. The wood is straight grained and strong. Trees less than 15 inches in diameter are most valuable for fork, hoe, shovel, spade, and scythe handles (snaths), baseball bats, and singletrees and doubletrees. Trees 15 inches and over in diameter are valuable for the above uses and for boat oars, wagon tongues, lumber for bent wood, other parts in car and vehicle construction, and sporting and athletic goods.

2. Large, clear, old-growth ash timber of all species holds its shape well and is especially valuable for dimension lumber (largely for resawing) for car and boat construction, interior finish, church, store, and office fixtures, vehicle and automobile bodies, and agricultural and musical instruments. (See Pl. III.)

3. Crooked and knotty ash timber and small, slow-growing trees (such as are found on poor, thin soils producing weak wood) and the lower grades of ash lumber can best be used for butter-tub staves and heading, woodenware, and novelties, chair and furniture stock, hames, and other uses in which short, clear pieces, such as can be cut out from between knots, can be utilized.

4. Clear black ash timber over 15 inches in diameter, the supply of which is very limited, is especially valuable for butter-tub hoops, splints for baskets, and chair bottoms, and for interior finish.

The owner of ash timber who wishes to sell it will find it advisable:

(1) To determine for what uses it is most valuable; (2) to get in touch with local firms who handle ash or consume it in these uses; (3) to write to State forestry officials or to the Forest Service, Washington, D. C., for wood-using reports which give the names and addresses of firms in the various industries which consume ash; (4) to select names of firms in industries using ash as one of the chief woods, and find out by correspondence which of them is in the market for ash; (5) to write to these firms stating what ash is for sale, and ask them for specifications in regard to the clearness, size, shape, and grade of the material which they wish to purchase, and for prices on such material either standing or in log f. o. b. local station, or sawed into special forms.

APPENDIX.

CLASSIFIED USES OF ASH IN DIFFERENT WOOD-USING INDUSTRIES.

1. HANDLES.

Axe; broom and mop; cant hook; carrying (for pianos); cultivator; D-fork; D-shovel; D-spade; edge tool; engravers' tool; file; grubbing hoe; hammer; hand drill; hand spike; hatchet; hay fork; hay knife; hoe; ice hook; jack; manure fork; maul; mop; oyster tongs; paint brush; peavy; pick; pole brush; potato hoe poles; pump; rake; scoop; shovel; snath; snow shovel, spade; spade; stable forks; tool (small and large); torch; track tool; trowel.

2. DAIRY SUPPLIES.

Butter packages; butter tubs (staves, heading, and hoops); butter paddles and workers; cheese boxes; churns and churn parts.

3. VEHICLES AND VEHICLE PARTS.

[In automobiles, buggies, bobsleds, carriages, gocarts, pushcarts, sleighs, sleds, trucks, wagons, and wheelbarrows.]

Bentwood for bows; bodies, frames, beds, and sears (including sills, running boards, panels, slats, sides, tops, footboards, gates, and braces); hounds—spring bars, tongue hounds, front and rear hounds, and bolsters; poles, shafts, and tongues; pungs and pung frames; reachers and risers; rims or felloes, and spokes; single and doubletrees, and eveners; sled and sled runners; yokes.

4. PLANING-MILL PRODUCTS, SASH, DOORS, AND BLINDS, AND GENERAL MILL WORK.

Baselvards; beams (for ceilings, etc.); blinds; brackets; cabinetwork; casing (for door and window); colonades; colonial columns; consoles; corner blocks; doors; door jambs; finish; flooring; frames, window; interior trim; lath; nosing; panels; partition; plate rails and racks; railing; rosettes (wall and stair); sash; screens; siding; sills; shelving; stair (string boards); veneered panels; wainscoting; wainscot rail; window aprons; weather stripping.

5. REFRIGERATORS AND KITCHEN CABINETS.

Ice boxes; ice chests; kitchen cabinets; refrigerators.

6. CAR CONSTRUCTION.

[Passenger, Pullman, and street cars, locomotive cabs, freight and dump cars.]

Boxes (casting for controller box); boxes (roller sign for electric cars); bulkheads (passenger cars); carlins (on electric cars); chair arms (railway cars); covers (switch boxes on electric cars); car blocking; cornice posts; cupboard doors (on railway cars); dust guards; facing window partition; frames, window; framework (trolley cars); interior finish; panels; partitions; posts; rafters; seats (electric cars); vestibules; wainscoting; windows.

7. FURNITURE.

Antique furniture; beds, folding; bed slats; benches (mess); benches (piano); bookcases; book racks; buffets; bureaus; cabinets (music); camp furniture; castors; chamber suits; chiffoniers; china

closets; commodes; couch frames and poles; cradles, baby; davenports; desks; drawer sides and bottoms; dressers; frames for parlor furniture; hall racks; lawn furniture; lodge furniture; magazine racks, school furniture; settee hammocks; sideboards; sofas; tables, extension, kitchen, library, mess (in boats), sewing, telephone; table slides; table legs; table tops; umbrella stands; wardrobes; washstands.

8. AGRICULTURAL IMPLEMENTS.

Corn huskers; corn planters; corn shellers; cotton planter parts; cradles, grain; cultivator beams; feeders; fingers, grain cradle; grain drills, feeders, and separators; harrows; harvesters; hay presses; hayloader parts; hayrack parts; hoppers, fruit and vegetable; manure spreader parts; peanut picker parts; peanut planter; plow handles; plow poles; plow rungs and pins; rake teeth; reaper slats; roller frames; rollers; seeding machine (pan sides, riddles); shredder; stacker parts; thills, seeder; thrasher; windwill parts; windmills.

9. BOXES AND CRATES.

Basket hoops; baskets; baskets, slat; baskets, split; box ends; boxes, ammunition; boxes, comb; boxes, creamery shipping; boxes, ditty; boxes, knife; boxes, medicine; boxes, mill and supply; boxes, salt; boxes, tinplate; boxes, woven splint; crates, vegetable; crating.

10. SHIP AND BOAT BUILDING.

Boat frames; cabins, interior; canoe decking; canoes; coaming, motor boat; covers, hatchway (ship); finish, trimming; grilles (ship and boat cabins); keels, motor boat; knees; launches; oars, boat; paddles; rails, yacht; ribs (boat and canoe); stays, boat; stems (boat and canoe); tillers; wheels, pilot.

11. SPORTING AND ATHLETIC GOODS.

Balls; baseball bats; billiard cues; billiard rails; croquet sets; fishing rods; gymnasium goods; hockey sticks; parallel bars; pike poles; polo sticks; skis; sleds; snowshoes; spring bars; tennis rackets; toboggans.

12. FIXTURES.

Cabinets; cabinets, medicine; cases, show; cases, lining; church fixtures; church pews; counter tops; display racks; drafting tables; frames, show-case; shelves, store fixtures; stanchions.

13. CHAIRS.

Chair backs; chair bottoms; chair frames; chair legs; chair posts (bent and straight); chair rockers; chair seats; chair-wheel parts; chair-cushion frames; kitchen chairs; stools.

14. MUSICAL INSTRUMENTS.

Actions, piano; banjo; drums; harps; moldings (piano); organ frames; organs; pipe-organ casting; pipe organs; piano backs; piano bottom boards; piano cases; piano facings; piano fronts; piano keys; piano keyboards; piano pilasters; piano players (inside work); piano tops; talking machines; tambourines.

15. WOODENWARE AND NOTIONS.

Blackboards, children's; bottoms, dry measure; buckets (sugar, jelly); carving boards; cattle guards; clothes bars; cloth boards; coffee mills; curtain pole, swing cleats; door knobs; doorstops; drain boards; drawer stops; fish nets; frames (coal, gravel, sand screens); frames (cutter); frames, roller; frames, sieve; heading (nail keg); hoops, bucket; hose, menders; kegs, putty; kegs, spice; ladder rounds; ladders; ladders, extension; lard tubs; measures; pails, candy; plane bodies; planks (fish, steak); plugs; reels, garden hose; rollers, towel; signaling devices.

16. SADDLES AND HARNESS.

Fillers, scotch hame; neck yoke; saddletrees; saddles; yokes.

17. MACHINE CONSTRUCTION.

Cylinders (cider mill); cylinders (flour mill); loom parts; machinery (flour mill); machinery (gin); parts, engine; parts, road machinery; sawmills (portable); scroll-saw tops; well-digging machine.

18. PUMPS.

Pump rods; sucker rods; well machinery.

19. TOYS.

Toys; hobby horses; toy automobiles; toy rakes; toy shovels; toy wagons.

20. PLUMBERS' WOODWORK.

Toilet seats; toilet tanks; sink drain boards.

21. TRUNKS.

Trunk slats; trunk strips; trunks.

22. PULLEY AND CONVEYORS.

Brake blocks; tackle blocks; timber grapples; wood pulleys.

23. PICKER STICKS AND BOBBINS.

Bobbins; picker sticks.

24. PRINTING MATERIAL.

Cabinets, printers'; cases, printers'; press platforms; printing-press forms; printers' supplies.

25. PICTURE FRAMES AND MOLDING.

Mirrors; molding, picture.

26. CARPET SWEEPERS.

Boxes, carpet sweepers; parts, carpet sweepers.

27. PLAYGROUND EQUIPMENT.

Playground apparatus; lawn swings; porch swings.

28. ROLLERS, SHADE AND MAP.

Rollers, shade and map; venetian blinds.

29. ELEVATORS.

Cars (dumb waiter); cars, elevator; dumb waiter (cleats, battery); flooring, cars (passenger and freight); frames (elevator cars); gates; grain elevators; guide posts (dumb waiter); strips (elevator cars).

30. INSTRUMENTS, PROFESSIONAL AND SCIENTIFIC.

Army supplies; boxes, miter; chests (draftsman's); firearms; litters (Army); medicine cases; tripods.

31. LAUNDRY APPLIANCES.

Clothes racks; frames, curtain; frames, wash tray; frames, wash tub; washboards; washing machines; washing-machine rubbers; washing-machine tops.

32. MACHINERY AND ELECTRICAL APPARATUS.

Electrical apparatus, parts; battery boxes.

33. MINE EQUIPMENT.

Lagging; stone boats.

34. BRUSHES.

Brush backs.

35. PATTERNS AND FLASKS.

Brick molds; pattern machine parts; patterns.

36. WHIPS.

Whip handles.

37. DOWELS.

Dowels.

38. CASKETS AND COFFINS.

Coffins.

39. BUTCHERS' BLOCKS AND SKEWERS.

Fixtures, butchers'; supplies, butchers'.

40. AEROPLANES.

Frames; propellers.

41. WEIGHING APPARATUS.

Scales.

42. GATES AND FENCING.

Fencing; pickets.

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